WEST Search History

Hide Items | Restore | Clear | Cancel

DATE: Monday, November 12, 2007

Hide?	Set Name	Query	Hit Count
		DB=PGPB,USPT,USOC,EPAB,JPAB,DWPI,TDBD; PLUR=YES; OP=ADJ	
☐	L46	L45 and (shim with (patient or subject or object))	7
☐	L45	l43 and (sheet)	23
☐	L44	l43 and (blanket)	0
☐	L43	L41 and l24	31
☐	L42	L41 and ((insertable or insert$3) with (carbon or carboniz$3 or carbonization or "c" or plastic$4))	2
☐	L41	(((magnetic adj resonan$2) or MRI or NMR) same((shim$4) same (sheet or blanket or foil)))	71
☐	L40	L1 and ((insertable or insert$3) with ((shim$4) same (sheet or blanket or foil)))	4
☐	L39	L37 and ((shim$4 or improv$3 or correct$3) same (magnetic) same (field))	4
☐	L38	L37 and ((shim$4 or improv$3 or correct$3) same (homogeneous or homogeneity or homogeniz$3) same (magnetic) same (field))	0
☐	L37	L1 and ((insertable or insert$3) with ((carbon or carboniz$3 or carbonization or "c" or plastic$4) same (sheet or blanket or foil)))	178
☐	L36	L35 and ((high or highly or higher or highest or strong$3 or strength or strengthen$3 or intense or intensity) same (magnetic) same (field))	1
☐	L35	L1 and ((insertable or insert$3) with ((carbon or carboniz$3 or carbonization or "c" or plastic$4) same (coat$3 or cover$3) same (sheet or plate or blanket or foil)))	29
☐	L34	L33 and ("t" or tesla or "3T" or "4T" or "5T" or "6T" or "7T")	12
☐	L33	L32 and ((high or highly or higher or highest or strong$3 or strength or strengthen$3 or intense or intensity) same (magnetic) same (field))	14
☐	L32	L31 and ((replac$3 or replacement or replaceable or replacible or detatch$4 or detach$4 or remov$4 or separat$3 or seperable) same ((carbon or carboniz$3 or carbonization or "c" or plastic$4) same (coat$3 or cover$3) same (sheet or plate or blanket or foil)))	14
☐	L31	L30 and (replac$3 or replacement or replaceable or replacible or detatch$4 or detach$4 or remov$4 or separat$3 or seperable)	54
☐	L30	L29 and ((shim$4 or improv$3 or correct$3 or homogeneous or homogeneity or homogeniz$3) same (magnetic) same (field))	54
☐	L29	l14 and ((carbon or carboniz$3 or carbonization or "c" or plastic$4) same (coat$3 or cover$3) same (sheet or plate or blanket or foil))	1041
☐	L28	L27 and l24	7
☐	L27	L26 and ((carbon or "c") same (coat$3 or cover$3) same (sheet or plate or blanket or foil))	44
☐	L26	L14 and ((shim$4 or improv$3 or correct$3 or homogeneous or homogeneity or homogeniz$3) same (magnetic) same (field))	520
☐	L25	L24 and l21	4
☐	L24	((324/300-322.ccls.) or (600/407-435.ccls.))	18635
☐	L23	L21 and ((replac$3 or replacement or replaceable or replacible or detatch$4 or detach$4 or remov$4) same ((carbon or carboniz$3 or "c") same (coat$3 or cover$3) same (sheet or plate	7

		or blanket or foil)))	
☐	L22	L21 and ((replac$3 or replacement or replaceable or replacible or detatch$4 or detach$4 or remov$4) same ((carbon or "c") same (coat$3 or cover$3) same (sheet or plate or blanket or foil)))	7
☐	L21	L20 and (((magnetic adj resonan$2) or MRI or NMR) same (cavity or (examination with (area or zone or volume or region)) or ROI or VOI or space or gap or opening))	44
☐	L20	L19 and (replac$3 or replacement or replaceable or replacible or detatch$4 or detach$4 or remov$4)	767
☐	L19	L14 and ((carbon or "c") same (coat$3 or cover$3) same (sheet or plate or blanket or foil))	783
☐	L18	L14 and ((carbon or "c") same (coat$3 or cover$3) same (sheet or plate pr blanket or foil))	292
☐	L17	L16 and ("t" or tesla or "3T" or "4T" or "5T" or "6T" or "7T")	5
☐	L16	L15 and (resist$4)	10
☐	L15	L14 and ((thick$4 or thickening) same (conduct$4 or conductivity or conductive$2) same (cavity or (examination with (area or zone or volume or region)) or ROI or VOI or space or gap or opening) same (isotropic$4 or anisotropic$4 or an-isotropic$4 or anisotrop$4))	15
☐	L14	L13 and (conduct$4 or conductivity or conductive$2)	5084
☐	L13	L1 and (isotropic$4 or anisotropic$4 or an-isotropic$4 or anisotrop$4)	8727
☐	L12	L11 and ((thick$4 or thickening) same (conduct$4 or conductivity or conductive$2) same (cavity or (examination with (area or zone or volume or region)) or ROI or VOI or space or gap or opening) same (isotropic$4 or anisotropic$4 or an-isotropic$4))	11
☐	L11	l2 and (conduct$4 or conductivity or conductive$2)	3920
☐	L10	l8 not l9	4
☐	L9	L8 and (replac$3 or replacement or replaceable or replacible or detatch$4 or detach$4 or remov$4)	15
☐	L8	L7 and (resist$4)	19
☐	L7	L6 and ("t" or tesla or "3T" or "4T" or "5T" or "6T" or "7T")	47
☐	L6	L5 and ((isotropic$4 or anisotropic$4 or an-isotropic$4) same (conduct$4 or conductivity or conductive$2) same (thick$4 or thickening))	71
☐	L5	L4 and (thick$4 or thickening)	446
☐	L4	L3 and ((isotropic$4 or anisotropic$4 or an-isotropic$4) same (conduct$4 or conductivity or conductive$2))	581
☐	L3	L2 and (conduct$4)	3756
☐	L2	L1 and (isotropic$4 or anisotropic$4 or an-isotropic$4)	6980
☐	L1	((magnetic adj resonan$2) or MRI or NMR)	264476

END OF SEARCH HISTORY

Hit List

First Hit Clear | Generate Collection | Print | Fwd Refs | Bkwd Refs | Generate OACS

Search Results - Record(s) 1 through 15 of 15 returned.

☐ 1. Document ID: US 20070184212 A1

L9: Entry 1 of 15 File: PGPB Aug 9, 2007

PGPUB-DOCUMENT-NUMBER: 20070184212
PGPUB-FILING-TYPE:
DOCUMENT-IDENTIFIER: US 20070184212 A1

TITLE: Polarizer-protective film, and polarizer and liquid-crystal display device comprising the film

PUBLICATION-DATE: August 9, 2007

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY
Nimura; Shigeaki	Minami-Ashigara-shi		JP
Kobayashi; Takashi	Fujinomiya-shi		JP
Watanabe; Hidetoshi	Minami-Ashigara-shi		JP
Watanabe; Jun	Minami-Ashigara-shi		JP
Suzuki; Takato	Minami-Ashigara-shi		JP

US-CL-CURRENT: 428/1.31

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KWIC | Draw Desc | Image

☐ 2. Document ID: US 20070178324 A1

L9: Entry 2 of 15 File: PGPB Aug 2, 2007

PGPUB-DOCUMENT-NUMBER: 20070178324
PGPUB-FILING-TYPE:
DOCUMENT-IDENTIFIER: US 20070178324 A1

TITLE: Microporous polypropylene film and process for producing the same

PUBLICATION-DATE: August 2, 2007

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY
Masuda; Jun'ichi	Kyoto		JP
Ohkura; Masatoshi	Shiga		JP
Tanaka; Shigeru	Shiga		JP
Morita; Reiko	Shiga		JP
Fukushima; Hajime	Kyoto		JP

US-CL-CURRENT: 428/500

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KWIC | Draw Desc | Image

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3. Document ID: US 20070082291 A1

L9: Entry 3 of 15 File: PGPB Apr 12, 2007

PGPUB-DOCUMENT-NUMBER: 20070082291
PGPUB-FILING-TYPE:
DOCUMENT-IDENTIFIER: US 20070082291 A1

TITLE: Lithographic Printing Plate Precursor and Lithographic Printing Method

PUBLICATION-DATE: April 12, 2007

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY
KAKINO; Ryuki	Shizuoka		JP
Kunita; Kazuto	Shizuoka		JP
Oohashi; Hidekazu	Shizuoka		JP
Oshima; Yasuhito	Shizuoka		JP

US-CL-CURRENT: 430/270.1

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KWIC | Draw Desc | Image

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4. Document ID: US 20060232726 A1

L9: Entry 4 of 15 File: PGPB Oct 19, 2006

PGPUB-DOCUMENT-NUMBER: 20060232726
PGPUB-FILING-TYPE:
DOCUMENT-IDENTIFIER: US 20060232726 A1

TITLE: Cellulose acylate film, optical compensation film, method of producing cellulose acylate film, polarizing plate and liquid crystal display

PUBLICATION-DATE: October 19, 2006

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY
Omatsu; Tadashi	Minami-Ashigara-shi		JP
Senga; Takeshi	Minami-Ashigara-shi		JP
Nozoe; Yutaka	Minami-Ashigara-shi		JP
Fukagawa; Nobutaka	Minami-Ashigara-shi		JP

US-CL-CURRENT: 349/96; 428/1.31

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KWIC | Draw Desc | Image

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5. Document ID: US 20050271981 A1

L9: Entry 5 of 15 File: PGPB Dec 8, 2005

PGPUB-DOCUMENT-NUMBER: 20050271981
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20050271981 A1

TITLE: Method for colored image formation

PUBLICATION-DATE: December 8, 2005

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY
Oohashi, Hidekazu	Haibara-gun		JP
Kunita, Kazuto	Haibara-gun		JP

US-CL-CURRENT: 430/300

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KWIC | Draw Desc | Image

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☐ 6. Document ID: US 20050271976 A1

L9: Entry 6 of 15 File: PGPB Dec 8, 2005

PGPUB-DOCUMENT-NUMBER: 20050271976
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20050271976 A1

TITLE: Lithographic printing plate precursor and lithographic printing method

PUBLICATION-DATE: December 8, 2005

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY
Kakino, Ryuki	Shizuoka		JP
Kunita, Kazuto	Shizuoka		JP
Oohashi, Hidekazu	Shizuoka		JP
Oshima, Yasuhito	Shizuoka		JP

US-CL-CURRENT: 430/270.1

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KWIC | Draw Desc | Image

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☐ 7. Document ID: US 20050070442 A1

L9: Entry 7 of 15 File: PGPB Mar 31, 2005

PGPUB-DOCUMENT-NUMBER: 20050070442
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20050070442 A1

TITLE: Mercury-based oxide superconductor composition

PUBLICATION-DATE: March 31, 2005

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY
Holcomb, Matthew J.	Metamora	MI	US

US-CL-CURRENT: 505/100

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KWIC | Draw Desc | Image

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☐ 8. Document ID: US 20030155667 A1

L9: Entry 8 of 15 File: PGPB Aug 21, 2003

PGPUB-DOCUMENT-NUMBER: 20030155667
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20030155667 A1

TITLE: Method for making or adding structures to an article

PUBLICATION-DATE: August 21, 2003

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY
Devoe, Robert J	Oakdale	MN	US
Duerr, Brook F	Lake Elmo	MN	US
Fleming, Patrick R	Lake Elmo	MN	US
Kalweit, Harvey W	Burnsville	MN	US

US-CL-CURRENT: 264/1.27; 264/1.31, 264/16, 264/482, 264/494

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KWIC | Draw Desc | Image

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☐ 9. Document ID: US 20030002132 A1

L9: Entry 9 of 15 File: PGPB Jan 2, 2003

PGPUB-DOCUMENT-NUMBER: 20030002132
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20030002132 A1

TITLE: Photochromic electrophoretic ink display

PUBLICATION-DATE: January 2, 2003

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY
Foucher, Daniel A.	Rochester	NY	US
Patel, Raj D.	Oakville		CA
Chopra, Naveen	Oakville		CA
Kazmaier, Peter M.	Mississauga		CA
Wojtyk, James	Ottawa		CA
Buncel, Erwin	Kingston		CA

US-CL-CURRENT: 359/296

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KWIC | Draw Desc | Image

10. Document ID: US 7229927 B1

L9: Entry 10 of 15 File: USPT Jun 12, 2007

US-PAT-NO: 7229927
DOCUMENT-IDENTIFIER: US 7229927 B1

TITLE: Semiconductor processing silica soot abrasive slurry method for integrated circuit microelectronics

DATE-ISSUED: June 12, 2007

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Darcangelo; Charles M.	Corning	NY		US
Sabia; Robert	Corning	NY		US
Sell; Robert D.	Horseheads	NY		US
Stevens; Harrie J.	Corning	NY		US
Ukrainczyk; Ljerka	Painted Post	NY		US

US-CL-CURRENT: 438/693; 257/E21.23, 257/E21.304

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw Desc | Image

11. Document ID: US 6812065 B1

L9: Entry 11 of 15 File: USPT Nov 2, 2004

US-PAT-NO: 6812065
DOCUMENT-IDENTIFIER: US 6812065 B1

TITLE: Anisotropic conductive paste

DATE-ISSUED: November 2, 2004

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Kitamura; Tadashi	Yokohama			JP

US-CL-CURRENT: 438/119; 156/330, 156/99, 252/518.1, 252/521.3, 349/122, 349/153, 428/1.1, 428/1.5, 428/1.52, 428/1.53, 428/413, 428/414, 428/415, 428/417

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw Desc | Image

12. Document ID: US 6730736 B1

L9: Entry 12 of 15 File: USPT May 4, 2004

US-PAT-NO: 6730736
DOCUMENT-IDENTIFIER: US 6730736 B1

TITLE: Alicyclyc structure-containing resin composition

DATE-ISSUED: May 4, 2004

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Kaita; Shojiro	Saitama			JP
Iga; Takashi	Kanagawa			JP
Wakizaka; Yasuhiro	Kanagawa			JP
Tsunogae; Yasuo	Kanagawa			JP

US-CL-CURRENT: 525/70; 525/210, 525/216, 525/71, 525/75, 525/80, 525/87, 525/93, 525/97

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw Desc | Image

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☐ 13. Document ID: US 6517618 B2

L9: Entry 13 of 15 File: USPT Feb 11, 2003

US-PAT-NO: 6517618
DOCUMENT-IDENTIFIER: US 6517618 B2

TITLE: Photochromic electrophoretic ink display

DATE-ISSUED: February 11, 2003

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Foucher; Daniel A.	Rochester	NY		
Patel; Raj D.	Oakville			CA
Chopra; Naveen	Oakville			CA
Kazmaier; Peter M.	Mississauga			CA
Wojtyk; James	Ottawa			CA
Buncel; Erwin	Kingston			CA

US-CL-CURRENT: 106/31.16; 106/31.32, 106/31.49, 106/31.64, 106/31.78

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw Desc | Image

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☐ 14. Document ID: US 5518664 A

L9: Entry 14 of 15 File: USPT May 21, 1996

US-PAT-NO: 5518664
DOCUMENT-IDENTIFIER: US 5518664 A

TITLE: Programmable electroset processes

DATE-ISSUED: May 21, 1996

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Reitz; Ronald P.	Hyattsville	MD		

US-CL-CURRENT: 252/500; 219/770, 252/511, 252/512, 252/572, 252/62.9R, 264/402

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw Desc | Image

☐ 15. Document ID: US 3461431 A

L9: Entry 15 of 15 File: USOC Aug 12, 1969

US-PAT-NO: 3461431
DOCUMENT-IDENTIFIER: US 3461431 A

TITLE: HIGH SPEED THIN FILM MEMORY

DATE-ISSUED: August 12, 1969

INVENTOR-NAME: ELLINGER PAUL B; KUNO HIROMU JOHN

US-CL-CURRENT: 365/139, 365/130, 365/134, 365/171, 365/193, 365/210

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw Desc | Image

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Term	Documents
REPLACEMENT	631900
REPLACEMENTS	44888
REPLACEABLE	147590
REPLACEABLES	12
REPLACIBLE	17
REPLACIBLES	0
REPLAC$3	0
REPLAC	5860
REPLACA	25
REPLACAB	2
REPLACACL	1
(L8 AND (REPLAC$3 OR REPLACEMENT OR REPLACEABLE OR REPLACIBLE OR DETATCH$4 OR DETACH$4 OR REMOV$4)).PGPB,USPT,USOC,EPAB,JPAB,DWPI,TDBD.	15

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☐ 1. Document ID: US 20070040962 A1

L10: Entry 1 of 4 File: PGPB Feb 22, 2007

PGPUB-DOCUMENT-NUMBER: 20070040962
PGPUB-FILING-TYPE:
DOCUMENT-IDENTIFIER: US 20070040962 A1

TITLE: Optical resin film and polarizing plate and liquid crystal display using same

PUBLICATION-DATE: February 22, 2007

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY
Ohgaru; Ikuko	Minami-Ashigara-shi		JP
Sugiyama; Susumu	Minami-Ashigara-shi		JP

US-CL-CURRENT: 349/96; 349/118

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KWIC | Draw Desc | Image

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☐ 2. Document ID: US 6494832 B1

L10: Entry 2 of 4 File: USPT Dec 17, 2002

US-PAT-NO: 6494832
DOCUMENT-IDENTIFIER: US 6494832 B1

TITLE: Multifrequency conductance catheter-based system and method to determine LV function in a patient

DATE-ISSUED: December 17, 2002

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Feldman; Marc D.	San Antonio	TX		
Valvano; Jonathan W.	Austin	TX		
Pearce; John A.	Austin	TX		

US-CL-CURRENT: 600/301

Full | Title | Citation | Front | Review | Classification | Date | Reference | Claims | KWIC | Draw Desc | Image

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☐ 3. Document ID: US 5990417 A

L10: Entry 3 of 4 File: USPT Nov 23, 1999

US-PAT-NO: 5990417
DOCUMENT-IDENTIFIER: US 5990417 A

TITLE: Electromagnetic noise absorbing material and electromagnetic noise filter

DATE-ISSUED: November 23, 1999

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Senda; Masakatsu	Mito			JP
Mori; Toshinori	Narashino			JP
Ishii; Osamu	Mito			JP
Koshimoto; Yasuhiro	Tokyo			JP
Toshima; Tomoyuki	Tokorozawa			JP

US-CL-CURRENT: 174/391; 174/394

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw Desc | Image

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☐ 4. Document ID: US 5729188 A

L10: Entry 4 of 4 File: USPT Mar 17, 1998

US-PAT-NO: 5729188
DOCUMENT-IDENTIFIER: US 5729188 A

TITLE: Homogeneous field magnet with at least one pole plate to be mechanically aligned

DATE-ISSUED: March 17, 1998

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Siebold; Horst	Erlangen			DE
Ries; Gunter	Erlangen			DE
Rockelein; Rudolf	Erlangen			DE

US-CL-CURRENT: 335/298; 324/319, 335/297

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw Desc | Image

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Clear | Generate Collection | Print | Fwd Refs | Bkwd Refs | Generate OACS

Term	Documents
(8 NOT 9).PGPB,USPT,USOC,EPAB,JPAB,DWPI,TDBD.	4
(L8 NOT L9).PGPB,USPT,USOC,EPAB,JPAB,DWPI,TDBD.	4

Display Format: - Change Format

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Search Results - Record(s) 1 through 11 of 11 returned.

☐ 1. Document ID: US 20070092432 A1

L12: Entry 1 of 11 File: PGPB Apr 26, 2007

PGPUB-DOCUMENT-NUMBER: 20070092432
PGPUB-FILING-TYPE:
DOCUMENT-IDENTIFIER: US 20070092432 A1

TITLE: Thermally exfoliated graphite oxide

PUBLICATION-DATE: April 26, 2007

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY
Prud'Homme; Robert K.	Lawrenceville	NJ	US
Aksay; Ilhan A.	Princeton	NJ	US
Adamson; Douglas	Skillman	NJ	US
Abdala; Ahmed	Suez		EG

US-CL-CURRENT: 423/448

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KWIC | Draw Desc | Image

☐ 2. Document ID: US 20060290442 A1

L12: Entry 2 of 11 File: PGPB Dec 28, 2006

PGPUB-DOCUMENT-NUMBER: 20060290442
PGPUB-FILING-TYPE:
DOCUMENT-IDENTIFIER: US 20060290442 A1

TITLE: Integrated microelectronics component for filtering electromagnetic noise and radio frequency transmission circuit comprising same

PUBLICATION-DATE: December 28, 2006

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY
Michel; Jean-Philippe	Corenc		FR
Lamy; Yann	Grenoble		FR
Royet; Anne-Sophie	Saint Martin Le Vinoux		FR
Viala; Bernard	Sassenage		FR

US-CL-CURRENT: 333/28R

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KWIC | Draw Desc | Image

3. Document ID: US 20050144005 A1

L12: Entry 3 of 11 File: PGPB Jun 30, 2005

PGPUB-DOCUMENT-NUMBER: 20050144005
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20050144005 A1

TITLE: System and method for speech generation from brain activity

PUBLICATION-DATE: June 30, 2005

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY
Kennedy, Philip R.	Duluth	GA	US

US-CL-CURRENT: 704/271; 704/E13.008, 704/E15.041

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KWIC | Draw Desc | Image

4. Document ID: US 20050019668 A1

L12: Entry 4 of 11 File: PGPB Jan 27, 2005

PGPUB-DOCUMENT-NUMBER: 20050019668
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20050019668 A1

TITLE: Ionic conduction structural member, secondary battery and method of producing same

PUBLICATION-DATE: January 27, 2005

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY
Yamamoto, Tomoya	Fukui		JP
Kawakami, Soichiro	Kanagawa		JP
Akasaka, Toshifumi	Kanagawa		JP

US-CL-CURRENT: 429/317; 429/231.4, 429/231.95, 521/27

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KWIC | Draw Desc | Image

5. Document ID: US 20030155667 A1

L12: Entry 5 of 11 File: PGPB Aug 21, 2003

PGPUB-DOCUMENT-NUMBER: 20030155667
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20030155667 A1

TITLE: Method for making or adding structures to an article

PUBLICATION-DATE: August 21, 2003

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY
Devoe, Robert J	Oakdale	MN	US
Duerr, Brook F	Lake Elmo	MN	US
Fleming, Patrick R	Lake Elmo	MN	US
Kalweit, Harvey W	Burnsville	MN	US

US-CL-CURRENT: 264/1.27; 264/1.31, 264/16, 264/482, 264/494

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KWIC | Draw Desc | Image

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☐ 6. Document ID: US 20030002132 A1

L12: Entry 6 of 11 File: PGPB Jan 2, 2003

PGPUB-DOCUMENT-NUMBER: 20030002132
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20030002132 A1

TITLE: Photochromic electrophoretic ink display

PUBLICATION-DATE: January 2, 2003

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY
Foucher, Daniel A.	Rochester	NY	US
Patel, Raj D.	Oakville		CA
Chopra, Naveen	Oakville		CA
Kazmaier, Peter M.	Mississauga		CA
Wojtyk, James	Ottawa		CA
Buncel, Erwin	Kingston		CA

US-CL-CURRENT: 359/296

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KWIC | Draw Desc | Image

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☐ 7. Document ID: US 7275035 B2

L12: Entry 7 of 11 File: USPT Sep 25, 2007

US-PAT-NO: 7275035
DOCUMENT-IDENTIFIER: US 7275035 B2

TITLE: System and method for speech generation from brain activity

DATE-ISSUED: September 25, 2007

PRIOR-PUBLICATION:

DOC-ID	DATE
US 20050144005 A1	June 30, 2005

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY

Kennedy; Philip R.	Duluth	GA		US

US-CL-CURRENT: 704/271; 704/267

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw Desc | Image

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8. Document ID: US 7229927 B1

L12: Entry 8 of 11 File: USPT Jun 12, 2007

US-PAT-NO: 7229927
DOCUMENT-IDENTIFIER: US 7229927 B1

TITLE: Semiconductor processing silica soot abrasive slurry method for integrated circuit microelectronics

DATE-ISSUED: June 12, 2007

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Darcangelo; Charles M.	Corning	NY		US
Sabia; Robert	Corning	NY		US
Sell; Robert D.	Horseheads	NY		US
Stevens; Harrie J.	Corning	NY		US
Ukrainczyk; Ljerka	Painted Post	NY		US

US-CL-CURRENT: 438/693; 257/E21.23, 257/E21.304

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw Desc | Image

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9. Document ID: US 6517618 B2

L12: Entry 9 of 11 File: USPT Feb 11, 2003

US-PAT-NO: 6517618
DOCUMENT-IDENTIFIER: US 6517618 B2

TITLE: Photochromic electrophoretic ink display

DATE-ISSUED: February 11, 2003

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Foucher; Daniel A.	Rochester	NY		
Patel; Raj D.	Oakville			CA
Chopra; Naveen	Oakville			CA
Kazmaier; Peter M.	Mississauga			CA
Wojtyk; James	Ottawa			CA
Buncel; Erwin	Kingston			CA

US-CL-CURRENT: 106/31.16; 106/31.32, 106/31.49, 106/31.64, 106/31.78

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw Desc | Image

10. Document ID: US 5729188 A

L12: Entry 10 of 11 File: USPT Mar 17, 1998

US-PAT-NO: 5729188
DOCUMENT-IDENTIFIER: US 5729188 A

TITLE: Homogeneous field magnet with at least one pole plate to be mechanically aligned

DATE-ISSUED: March 17, 1998

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Siebold; Horst	Erlangen			DE
Ries; Gunter	Erlangen			DE
Rockelein; Rudolf	Erlangen			DE

US-CL-CURRENT: 335/298; 324/319, 335/297

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw Desc | Image

11. Document ID: CN 1938600 A, WO 2005093450 A1, EP 1733245 A1

L12: Entry 11 of 11 File: DWPI Mar 28, 2007

DERWENT-ACC-NO: 2005-713966
DERWENT-WEEK: 200752
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TITLE: Magnetic resonance imaging system for diagnosis of tumor in patient's head, comprises electrically conductive material having conductivity and thickness so that total conductance in xy plane of cylindrical cavity becomes isotropic

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw Desc | Clip Img | Ima

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Term	Documents
THICKENING	115477
THICKENINGS	1707
CONDUCTIVITY	572857
CONDUCTIVITIES	22714
CONDUCTIVITYS	3
CAVITY	931114
CAVITIES	272720
CAVITYS	55

EXAMINATION	314566
EXAMINATIONS	27591
(L11 AND ((THICK$4 OR THICKENING) SAME (CONDUCT$4 OR CONDUCTIVITY OR CONDUCTIVE$2) SAME (CAVITY OR (EXAMINATION WITH (AREA OR ZONE OR VOLUME OR REGION)) OR ROI OR VOI OR SPACE OR GAP OR OPENING) SAME (ISOTROPIC$4 OR ANISOTROPIC$4 OR AN-ISOTROPIC$4))).PGPB,USPT,USOC,EPAB,JPAB,DWPI,TDBD.	11

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Search Results - Record(s) 1 through 15 of 15 returned.

1. Document ID: US 20070092432 A1

L15: Entry 1 of 15 File: PGPB Apr 26, 2007

PGPUB-DOCUMENT-NUMBER: 20070092432
PGPUB-FILING-TYPE:
DOCUMENT-IDENTIFIER: US 20070092432 A1

TITLE: Thermally exfoliated graphite oxide

PUBLICATION-DATE: April 26, 2007

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY
Prud'Homme; Robert K.	Lawrenceville	NJ	US
Aksay; Ilhan A.	Princeton	NJ	US
Adamson; Douglas	Skillman	NJ	US
Abdala; Ahmed	Suez		EG

US-CL-CURRENT: 423/448

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KWIC | Draw Desc | Image

2. Document ID: US 20060290442 A1

L15: Entry 2 of 15 File: PGPB Dec 28, 2006

PGPUB-DOCUMENT-NUMBER: 20060290442
PGPUB-FILING-TYPE:
DOCUMENT-IDENTIFIER: US 20060290442 A1

TITLE: Integrated microelectronics component for filtering electromagnetic noise and radio frequency transmission circuit comprising same

PUBLICATION-DATE: December 28, 2006

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY
Michel; Jean-Philippe	Corenc		FR
Lamy; Yann	Grenoble		FR
Royet; Anne-Sophie	Saint Martin Le Vinoux		FR
Viala; Bernard	Sassenage		FR

US-CL-CURRENT: 333/28R

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KWIC | Draw Desc | Image

3. Document ID: US 20050144005 A1

L15: Entry 3 of 15 File: PGPB Jun 30, 2005

PGPUB-DOCUMENT-NUMBER: 20050144005
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20050144005 A1

TITLE: System and method for speech generation from brain activity

PUBLICATION-DATE: June 30, 2005

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY
Kennedy, Philip R.	Duluth	GA	US

US-CL-CURRENT: 704/271; 704/E13.008, 704/E15.041

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KWIC | Draw Desc | Image

4. Document ID: US 20050019668 A1

L15: Entry 4 of 15 File: PGPB Jan 27, 2005

PGPUB-DOCUMENT-NUMBER: 20050019668
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20050019668 A1

TITLE: Ionic conduction structural member, secondary battery and method of producing same

PUBLICATION-DATE: January 27, 2005

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY
Yamamoto, Tomoya	Fukui		JP
Kawakami, Soichiro	Kanagawa		JP
Akasaka, Toshifumi	Kanagawa		JP

US-CL-CURRENT: 429/317; 429/231.4, 429/231.95, 521/27

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KWIC | Draw Desc | Image

5. Document ID: US 20030155667 A1

L15: Entry 5 of 15 File: PGPB Aug 21, 2003

PGPUB-DOCUMENT-NUMBER: 20030155667
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20030155667 A1

TITLE: Method for making or adding structures to an article

PUBLICATION-DATE: August 21, 2003

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY
Devoe, Robert J	Oakdale	MN	US
Duerr, Brook F	Lake Elmo	MN	US
Fleming, Patrick R	Lake Elmo	MN	US
Kalweit, Harvey W	Burnsville	MN	US

US-CL-CURRENT: 264/1.27; 264/1.31, 264/16, 264/482, 264/494

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KWIC | Draw Desc | Image

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☐ 6. Document ID: US 20030002132 A1

L15: Entry 6 of 15 File: PGPB Jan 2, 2003

PGPUB-DOCUMENT-NUMBER: 20030002132
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20030002132 A1

TITLE: Photochromic electrophoretic ink display

PUBLICATION-DATE: January 2, 2003

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY
Foucher, Daniel A.	Rochester	NY	US
Patel, Raj D.	Oakville		CA
Chopra, Naveen	Oakville		CA
Kazmaier, Peter M.	Mississauga		CA
Wojtyk, James	Ottawa		CA
Buncel, Erwin	Kingston		CA

US-CL-CURRENT: 359/296

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KWIC | Draw Desc | Image

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☐ 7. Document ID: US 7275035 B2

L15: Entry 7 of 15 File: USPT Sep 25, 2007

US-PAT-NO: 7275035
DOCUMENT-IDENTIFIER: US 7275035 B2

TITLE: System and method for speech generation from brain activity

DATE-ISSUED: September 25, 2007

PRIOR-PUBLICATION:

DOC-ID	DATE
US 20050144005 A1	June 30, 2005

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY

Kennedy; Philip R.	Duluth	GA		US

US-CL-CURRENT: 704/271; 704/267

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw Desc | Image

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8. Document ID: US 7229927 B1

L15: Entry 8 of 15 File: USPT Jun 12, 2007

US-PAT-NO: 7229927
DOCUMENT-IDENTIFIER: US 7229927 B1

TITLE: Semiconductor processing silica soot abrasive slurry method for integrated circuit microelectronics

DATE-ISSUED: June 12, 2007

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Darcangelo; Charles M.	Corning	NY		US
Sabia; Robert	Corning	NY		US
Sell; Robert D.	Horseheads	NY		US
Stevens; Harrie J.	Corning	NY		US
Ukrainczyk; Ljerka	Painted Post	NY		US

US-CL-CURRENT: 438/693; 257/E21.23, 257/E21.304

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw Desc | Image

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9. Document ID: US 6517618 B2

L15: Entry 9 of 15 File: USPT Feb 11, 2003

US-PAT-NO: 6517618
DOCUMENT-IDENTIFIER: US 6517618 B2

TITLE: Photochromic electrophoretic ink display

DATE-ISSUED: February 11, 2003

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Foucher; Daniel A.	Rochester	NY		
Patel; Raj D.	Oakville			CA
Chopra; Naveen	Oakville			CA
Kazmaier; Peter M.	Mississauga			CA
Wojtyk; James	Ottawa			CA
Buncel; Erwin	Kingston			CA

US-CL-CURRENT: 106/31.16; 106/31.32, 106/31.49, 106/31.64, 106/31.78

☐ 10. Document ID: US 5811971 A

L15: Entry 10 of 15 File: USPT Sep 22, 1998

US-PAT-NO: 5811971
DOCUMENT-IDENTIFIER: US 5811971 A

TITLE: Magnetic sensor and magnetic field sensing method using said magnetic sensor based on impedance changes of a high frequency excited conductor

DATE-ISSUED: September 22, 1998

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Senda; Masakatsu	Mito			JP
Ishii; Osamu	Mito			JP
Koshimoto; Yasuhiro	Higashiyamato			JP
Toshima; Tomoyuki	Tokorozawa			JP

US-CL-CURRENT: 324/244; 324/250, 324/260, 360/110

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw Desc | Image

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☐ 11. Document ID: US 5734267 A

L15: Entry 11 of 15 File: USPT Mar 31, 1998

US-PAT-NO: 5734267
DOCUMENT-IDENTIFIER: US 5734267 A
**** See image for Certificate of Correction ****

TITLE: Magnetic head, magnetic recording method using the magnetic head, and magnetic field sensing method using the magnetic head based on impedance changes of a high frequency excited conductor

DATE-ISSUED: March 31, 1998

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Senda; Masakatsu	Mito			JP
Ishii; Osamu	Mito			JP
Koshimoto; Yasuhiro	Higashiyamoto			JP
Toshima; Tomoyuki	Tokorozawa			JP

US-CL-CURRENT: 324/244; 324/250, 324/260, 360/110

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw Desc | Image

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☐ 12. Document ID: US 5729188 A

L15: Entry 12 of 15 File: USPT Mar 17, 1998

US-PAT-NO: 5729188
DOCUMENT-IDENTIFIER: US 5729188 A

TITLE: Homogeneous field magnet with at least one pole plate to be mechanically aligned

DATE-ISSUED: March 17, 1998

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Siebold; Horst	Erlangen			DE
Ries; Gunter	Erlangen			DE
Rockelein; Rudolf	Erlangen			DE

US-CL-CURRENT: 335/298; 324/319, 335/297

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw Desc | Image

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13. Document ID: US 5706813 A

L15: Entry 13 of 15 File: USPT Jan 13, 1998

US-PAT-NO: 5706813
DOCUMENT-IDENTIFIER: US 5706813 A

TITLE: Focal neurographic magnetic resonance imaging system

DATE-ISSUED: January 13, 1998

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Filler; Aaron G.	London			GB
Howe; Franklyn A.	London			GB2

US-CL-CURRENT: 600/422; 324/318

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw Desc | Image

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14. Document ID: US 5705926 A

L15: Entry 14 of 15 File: USPT Jan 6, 1998

US-PAT-NO: 5705926
DOCUMENT-IDENTIFIER: US 5705926 A
**** See image for Certificate of Correction ****

TITLE: Magnetic sensor and magnetic field sensing method of using same based on impedance changes of a high frequency supplied conductor

DATE-ISSUED: January 6, 1998

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Senda; Masakatsu	Mito			JP
Ishii; Osamu	Mito			JP
Koshimoto; Yasuhiro	Higashiyamato			JP
Toshima; Tomoyuki	Tokorozawa			JP

US-CL-CURRENT: 324/244; 324/207.13, 324/249, 324/250, 324/260, 360/110

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw Desc | Image

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15. Document ID: CN 1938600 A, WO 2005093450 A1, EP 1733245 A1

L15: Entry 15 of 15 File: DWPI Mar 28, 2007

DERWENT-ACC-NO: 2005-713966
DERWENT-WEEK: 200752

TITLE: Magnetic resonance imaging system for diagnosis of tumor in patient's head, comprises electrically conductive material having conductivity and thickness so that total conductance in xy plane of cylindrical cavity becomes isotropic

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw Desc | Clip Img | Ima

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Term	Documents
THICKENING	115477
THICKENINGS	1707
CONDUCTIVITY	572857
CONDUCTIVITIES	22714
CONDUCTIVITYS	3
CAVITY	931114
CAVITIES	272720
CAVITYS	55
EXAMINATION	314566
EXAMINATIONS	27591
(L14 AND ((THICK$4 OR THICKENING) SAME (CONDUCT$4 OR CONDUCTIVITY OR CONDUCTIVE$2) SAME (CAVITY OR (EXAMINATION WITH (AREA OR ZONE OR VOLUME OR REGION)) OR ROI OR VOI OR SPACE OR GAP OR OPENING) SAME (ISOTROPIC$4 OR ANISOTROPIC$4 OR AN-ISOTROPIC$4 OR ANISOTROP$4))).PGPB,USPT,USOC,EPAB,JPAB,DWPI,TDBD.	15

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L15: Entry 2 of 15 File: PGPB Dec 28, 2006

DOCUMENT-IDENTIFIER: US 20060290442 A1
TITLE: Integrated microelectronics component for filtering electromagnetic noise and radio frequency transmission circuit comprising same

Abstract Paragraph:
The integrated microelectronics component comprises an electric conductor forming a transmission line element for a radio frequency electromagnetic wave. This electric conductor is surrounded at least partially by a preferably closed magnetic circuit, formed at least by superposition of a layer of ferromagnetic material having a saturation magnetization value greater than or equal to 800 kA/m and of a layer of magnetic material. The layer of magnetic material then generates a uniaxial magnetic anisotropy in the adjacent ferromagnetic layer. A high magnetization can then be combined with a high anisotropy, thus enabling operation in high frequency ranges, for example about 5 to 20 GHz.

Brief Summary Text:
[0001] The invention relates to an integrated microelectronics component comprising an electric conductor forming a transmission line element for a radio frequency electromagnetic wave, and means for filtering electromagnetic noise, in particular by magnetic resonance, said means for filtering electromagnetic noise comprising a layer of ferromagnetic material. It also relates to a radio frequency transmission circuit comprising such a component.

Brief Summary Text:
[0007] According to the invention, this object is achieved by the accompanying claims and, more particularly by the fact that, the ferromagnetic material having a saturation magnetization value greater than or equal to 800 kA/m, the means for filtering electromagnetic noise are formed by a magnetic circuit surrounding the conductor and formed at least by superposition of said layer of ferromagnetic material and of a layer of magnetic material, in such a way that the layer of magnetic material generates a uniaxial magnetic anisotropy in the adjacent layer of ferromagnetic material.

Description of Disclosure:
[0018] In the particular embodiments represented in FIGS. 1 to 3, the integrated microelectronic component C, of MMIC type, comprises a substrate 1 whereon a layer 2 of insulating material is deposited. A conductor 3, constituting an element of a signal transmission line, is integrated in the layer 2. In FIGS. 2 and 3, the component C is integrated in a transmission circuit comprising two coplanar ground planes 4 parallel to the conductor 3 and arranged on each side thereof. In FIG. 3, the conductor 3 comprises contact studs 5 at the ends thereof, as do the ground planes 4.

Description of Disclosure:
[0019] Between two contact studs 5 arranged at its ends, the conductor 3 is surrounded by a magnetic circuit 6 designed to filter the electromagnetic noise, conventionally constituted by one or more stray frequencies and associated with the wave passing through the transmission line. In the preferred embodiment, represented in FIG. 2, the magnetic circuit 6 is a closed magnetic circuit, i.e. with no air-gap, surrounding the conductor 3 totally. In an alternative embodiment (FIGS. 13 and 14), the magnetic circuit 6 can comprise one or more air-gaps. It does however surround the conductor 3 practically totally.

Description of Disclosure:
[0020] In all cases, the walls of the magnetic circuit 6 are formed by superposition of at least two layers, i.e. a layer 7 of ferromagnetic material f and a layer 8 of magnetic material m. The order of the layers 7 and 8 with respect to the electric conductor 3 is of no importance.

Description of Disclosure:
[0022] Associating a layer 8 of magnetic material m and a layer 7 of ferromagnetic material f generates a uniaxial magnetic anisotropy in the adjacent layer of ferromagnetic material f or increases its natural anisotropy, for example by exchange coupling effect at the interface in the case where m is an antiferromagnetic layer.

Description of Disclosure:
[0023] This phenomenon has been mentioned in the article "AF-Biased CoFe Multilayer Films with FMR Frequency at 5 GHz and Beyond" by B. Viala et al., IEEE Transactions on Magnetics, vol. 40, n.sup.o4, July 2004, p. 1996-1998, which studies the properties of a thin layer of ferromagnetic material (CoFe), that is not naturally soft, between two thin layers of antiferromagnetic material, in the context of studies relating to increasing the magnetic resonance frequency of inductors used in RF circuits.

Description of Disclosure:
[0024] The preferably closed magnetic circuit 6 surrounding the electric conductor 3 acting as RF transmission line or as RF transmission line element thus forms a magnetic microresonator based on the gyromagnetic resonance effect (in the operating mode illustrated in FIG. 11) or on the wavelength reduction effect (in the operating mode illustrated in FIG. 12). The electromagnetic field generated by the transmission line is confined to the maximum inside the microresonator.

Description of Disclosure:
[0025] The conventional homogeneous anisotropic soft ferromagnetic materials and alloys conventionally used in microelectronics, in particular to form ferromagnetic inductors, only enable applications at relatively low frequency (up to 1 GHz). Indeed, these materials only offer intrinsic resonance frequencies of about 1 GHz maximum. On the other hand, associating a ferromagnetic material layer f and an antiferromagnetic material layer m allows the combination of a high uniaxial anisotropy Hk, for example greater than or equal to 40 kA/m (or Hk.gtoreq.500 Oe in C.G.S. units as 1 Oe=(1000/4.pi.) A/m), with a very strong saturation magnetization Ms.gtoreq.800 kA/m (i.e. 4.pi.Ms.gtoreq.10 kOe), and preferably about the maximum value of 1920 kA/m (i.e. 4.pi.Ms=24 kOe), which enables intrinsic resonance frequencies greater than or equal to 10 GHz to be obtained.

Description of Disclosure:
[0026] The two layers 7 and 8 have quite separate functions. Thus, the layer 7, made of ferromagnetic material f, first of all has the function of ensuring as high a saturation magnetization as possible. The ferromagnetic material does not need to be soft and is preferably formed by cobalt and iron alloys CoFe, which present the strongest magnetizations known at the present time. However, these materials had up to now been discarded for RF applications as they are not naturally soft. They do in fact have a too high coercitive field Hc, of about 3 kA/m (i.e. 40 Oe), whereas conventional soft materials, such as permalloy for example, are characterized by values typically lower than or equal to around 80 A/m (1 Oe). Iron and cobalt alloys, which do not have a uniaxial magnetic anisotropy either, whether it be natural or induced by conventional deposition processes under a magnetic field, therefore do not initially present the required dynamic properties for generating a ferro-magnetic resonance effect.

Description of Disclosure:
[0029] The layer 8 of magnetic material m has the function of ensuring the anisotropy of the layer 7 of ferromagnetic material. In a preferred embodiment, the magnetic material is an antiferromagnetic material. The antiferromagnetic materials used are preferably alloys having a base of manganese (Mn) and an element chosen from nickel (Ni), iron (Fe), platinum

Description of Disclosure:
[0043] As represented in FIG. 11, the component, in which the electric conductor 3 constitutes a RF transmission line element or a RF transmission line, can be used in its absorption band, with an operating point centred on the magnetic resonance frequency. It can also, as represented in FIG. 12, be used before its absorption band to increase the inductance and quality factor of the line and/or to reduce the length of the line by decreasing the signal wavelength. Such a transmission line element can then be used in a transmission line for microwave applications. This in particular enables the performances and compactness of existing circuits (RLC filters, half-wave and quarter-wave lines . . .) to be improved and new

functionalities to be created.

Description of Disclosure:
[0047] The component can be fabricated by standard fabrication methods used in microelectronics. FIGS. 13 to 15 illustrate, in cross-section, three possible alternative embodiments for producing the magnetic circuit 6 surrounding the electric conductor 3.

Description of Disclosure:
[0048] In the alternative embodiment of FIG. 13, a cavity is formed in the substrate 1. This cavity comprises a flat bottom and two inclined flat side walls widening upwards in the cavity. If the cavity is formed by anisotropic etching (KOH) in a substrate 1, made of Si<100> silicon for example, the inclined side walls of the cavity make an angle of 54.7.degree. with the horizontal. The bottom and walls of the cavity are covered by the insulating material 2. A bottom part of the magnetic circuit 6 is then formed by successive deposition of the different layers 7 and 8 constituting said circuit on the bottom and walls of the cavity. After a fresh deposition of insulating material 2, the electric conductor 3 is formed inside the cavity by deposition of the conductor, followed by planarization. A layer of insulating material 2, the thickness whereof controls the thickness of the air-gap of the magnetic circuit 6, is then deposited flat on the cavity. Then a flat wall forming the top part of the magnetic circuit 6 is formed by deposition of the different layers 7 and 8 above this last layer of insulator. As represented in FIG. 13, the magnetic circuit 6, surrounding almost the whole of the conductor 3, thus comprises two air-gaps between its bottom and top parts.

Description of Disclosure:
[0049] In the alternative embodiment of FIG. 14, a cavity is formed in a layer of insulating material 2 covering the substrate 1. As in FIG. 13, this cavity comprises a flat bottom and two upwardly-widening inclined side walls. It is formed in the insulating material 2 by etching from a lithographed photoresist (for example PFRIX420 19 Cp) presenting flanks at the pattern edge making an angle comprised between 10.degree. and 45.degree. with the horizontal. This angle can be adjusted for example using a proximity exposure technique with a controlled distance between the mask and photoresist. This controlled distance is typically comprised between 10 and 100 .mu.m. Another possible technique consists in using phase contrast masks. As in FIG. 13, the bottom part of the magnetic circuit 6 is then formed by successive deposition of the different layers 7 and 8 constituting same on the bottom and walls of the cavity. After a fresh deposition of insulating material 2, the electric conductor 3 is formed inside the cavity by deposition of the conductor, followed by planarization. A layer of insulating material 2, the thickness whereof controls the thickness of the air-gap of the magnetic circuit 6, is then deposited flat on the cavity. Then a flat wall forming the top part of the magnetic circuit 6 is formed by deposition of the different layers 7 and 8 above this last layer of insulator.

Description of Disclosure:
[0050] In the alternative embodiment of FIG. 15, the bottom part of the magnetic circuit 6 is formed by a flat wall formed on a layer 2 of insulating material by successive deposition of the different layers 7 and 8. After deposition of a new layer of insulating material 2 and planarization, the electric conductor 3 is formed inside a well made in the insulating material. It is then covered by the insulating material. The insulating material is then etched, up to the bottom part of the magnetic circuit 6, with a trapezoid shape, delineated by a flat top wall and by two upwardly-narrowing inclined side walls. As in the embodiment of FIG. 14, the trapezoid is formed in the insulating material 2 by etching from a lithographed photoresist (for example PFRIX420 19 Cp) presenting flanks at the pattern edge making an angle comprised between 10.degree. and 45.degree. with the horizontal. This angle can be adjusted for example using a proximity exposure technique with a controlled distance, typically comprised between 10 and 100 .mu.m, between the mask and photoresist, or by using phase contrast masks. The top part of the magnetic circuit is then formed by successive deposition of the different layers 7 and 8 constituting same on the flat top wall and on the inclined side walls of the trapezoid. The top part of the circuit 6 is in contact with the bottom part thereof, thus forming a closed magnetic circuit 6.

Description of Disclosure:
[0056] For example, a component C according to FIG. 1 can comprise: [0057] an electric conductor 3 and ground planes 4 with a width of 5 to 150 .mu.m, a length of 100 to 1000 .mu.m and a thickness of 0.5 to 5 .mu.m, [0058] an insulator 2, formed by a benzocyclobutene-base resin (BCB), with a thickness of less than 1 .mu.m between the electric conductor 3 and the

closed magnetic circuit 6, [0059] a stack of layers 7 and 8 (f/m)n as represented in FIG. 4, with n comprised between 1 and 100, in which the layers 7 of FeCo alloy each have a thickness comprised between 0.01 and 0.5 .mu.m and the layers 8 of NiMn alloy each have a thickness comprised between 0.01 and 0.05 .mu.m, or [0060] a stack of layers 7 and 8 (m/f/m)n according to FIG. 5, with a thickness of from 0.1 to 1 .mu.m.

Description of Disclosure:
[0064] In the circuits according to FIGS. 16 and 17, as in FIG. 3, the conductor 3 of the component C belongs to a central transmission line arranged between two lateral ground planes 4.

Description of Disclosure:
[0065] A transmission circuit can comprise several components C. The circuits according to FIGS. 18 and 19, for example, differ from the circuit according to FIG. 3 by the fact that they comprise two components (C1, C2), respectively arranged between a central transmission line (10) and the lateral ground planes (4). In FIG. 18, there is no electric connection between the central transmission line (10) and the conductors 3 of the components C1 and C2, whereas in FIG. 19, the electric conductors 3 of the components C1 and C2 are electrically connected to the central transmission line by connections 11 at the level of their ends. Several components C1 (or C2) can also be arranged, for example side by side or one above the other, between the central transmission line 10 and one of the ground planes 4.

CLAIMS:

1. Integrated microelectronics component comprising at least one electric conductor, forming a transmission line element for a radio frequency electromagnetic wave, and filtering means for filtering electromagnetic noise, wherein said means for filtering electromagnetic noise are formed by a magnetic circuit surrounding the conductor and formed at least by superposition of a layer of ferromagnetic material having a saturation magnetization value greater than or equal to 800 kA/m and of a layer of magnetic material, in such a way that the layer of magnetic material generates a uniaxial magnetic anisotropy in the adjacent layer of ferromagnetic material.

2. Component according to claim 1, wherein the magnetic circuit surrounding the conductor is a closed magnetic circuit.

3. Component according to claim 1, wherein the magnetic circuit surrounding the conductor comprises at least one air-gap.

17. Circuit according to claim 16, wherein the conductor of the component belongs to the central transmission line.

Previous Doc Next Doc Go to Doc#

L15: Entry 13 of 15 File: USPT Jan 13, 1998

DOCUMENT-IDENTIFIER: US 5706813 A
TITLE: Focal neurographic magnetic resonance imaging system

Abstract Text (1):
A focal magnetic resonance imaging system (20) for generating images of neural structures such as nerves. The system (20) includes a control and analysis system (22), a polarizing system (24), and splint-coil assembly (26). The splint-coil assembly (26) includes a splint (28) and various magnetic and electromagnetic coils (32,40,42) incorporated within the splint (28). The splint (28) conforms snugly to a patient's body part, e.g., limb, so that the coils (32,40,42) are fixed with respect to the patient's body part. The splint-coil assembly (26) can be positioned independently of a main field generated by the polarizing system (24), and a stabilization apparatus (156) is included for adjustably securing the position of the splint-coil assembly (26) during imaging. A focal magnet assembly (60) that can serve as the polarizing system (24) is also provided. Further provided is a method of operating the control and analysis system (22) to consistently generate images depicting the fascicular structure of nerves (100) by ensuring that image gradients (108) are oriented orthogonal to the nerves (100).

Brief Summary Text (2):
The present invention relates generally to the field of magnetic resonance imaging and, more particularly, to the imaging of nerve tissue.

Brief Summary Text (4):
Magnetic resonance imaging (MRI) is being increasingly used to image physiological structures. MRI involves the exposure of a specimen to a variety of different magnetic and radio-frequency (if) electromagnetic fields. The response of the specimen's atomic nuclei to the fields is processed to produce an image of the specimen. More particularly, the specimen is exposed to a polarizing magnetic field, also commonly referred to as the main field. Then, an excitation field is applied perpendicular to the main field, and the resulting resonant electromagnetic responses of nuclei within the specimen is observed. The resonant electromagnetic responses of nuclei within the specimen vary for different types of nuclear species or for different chemical environments for nuclei of a single species, e.g., hydrogen. Thus, by analyzing the resonant electromagnetic responses (e.g., using a Fourier analysis), various nuclear environments and species, and therefore various component tissues, contained in the specimen can be differentiated.

Brief Summary Text (6):
Presently, to generate these various magnetic and electromagnetic fields, magnetic resonance (MR) imaging machines 10, as shown in FIG. 1, include various coils housed and fixed in the walls of a bore 12 into which a person is inserted for imaging. The presently available MR imaging machines 10 are generally whole-body imagers, i.e., the bore 12 is large enough so that a person 14 can be slid lengthwise into the bore, and an entire cross-section of the person can be imaged. A main field coil is included in the imaging machine 10 to produce a uniform main field. In order to produce a homogenous field throughout the relatively large interior of the bore 12 with a reasonable amount of electrical power, an elaborate solenoid-type system is used. In particular, liquid helium and liquid nitrogen are used to cool the main field coil to maintain a near superconducting circuit.

Brief Summary Text (9):
These whole-body MR imaging machines 10 have been used to image various physiological structures. Recently, new processes utilizing magnetic resonance have been developed to generate sharp images of neural structures, including peripheral nerves. Some of these new processes, which are disclosed in the original parent U.S. patent application Ser. No.

08/028,795, exploit anisotropic diffusion exhibited by neural structures including peripheral nerves. Anisotropic diffusion refers to the fact that a neural structure, e.g., a nerve, exhibits fluid mobility along the length of the neural structure, while fluid motion is restricted in directions perpendicular to length, i.e., the longitudinal axis, of the neural structure. By generating a set of magnetic field gradients in addition to the imaging gradients, neural structures that exhibit anisotropic diffusion are enhanced in the resulting MR images. In other words, the additional gradients allow the discrimination of fluid diffusion anisotropy exhibited by neural structures. The additional gradients are referred to as diffusion gradients, and the imaging technique is referred to generally as diffusion-weighted imaging.

Brief Summary Text (10):
In one of the diffusion-weighted imaging techniques disclosed in the original parent U.S. patent application Ser. No. 08/028,795, after carrying out fat suppression, diffusion gradients are applied perpendicular and parallel to the longitudinal axis of the neural structure, e.g., nerve, of interest. In particular, two images are generated, one with the diffusion gradient oriented perpendicular to the length of the nerve and the second image generated with the diffusion gradient oriented parallel to the length of the nerve. Because, uniquely in nerves, a large portion of the fluid flow occurs only along the length of the nerve, the anisotropic nature of the fluid flow affects the two images differently. Specifically, when the diffusion gradient is aligned with the nerve, the fluid flow causes a reduction in the signal strength from the nerve. In contrast, the anisotropic fluid flow does not affect the image generated with the diffusion oriented perpendicular to the nerve. By processing these two images, a resultant image can be generated in which the nerve stands out from other structures in the region. In fact, all other structures can be suppressed so that an image in which only the nerve appears is obtained; this image is referred to as a neurogram.

Brief Summary Text (11):
Unfortunately, for various reasons, presently available whole-body imaging machines 10 do not allow for the best exploitation of this neurographic imaging technique or the other neurographic imaging techniques disclosed in the original parent U.S. patent application Ser. No. 08/028,795. First, to effectively discriminate diffusion anisotropy in small neural structures, such as peripheral nerves, high strength diffusion gradients are often needed. For example, while standard whole-body imaging machines 10 are generally used to generate magnetic field gradients of about one Gauss per centimeter, higher strength diffusion gradients on the order of 10 Gauss per centimeter are often desirable to best discriminate the diffusion anisotropy exhibited by nerves. Typically, the gradient coils that are used to generate the imaging gradients are also used to generate the diffusion gradients. There is a practical upper limit to the strength of gradients that can be generated using these gradient coils in standard whole-body imaging machines 10, because the gradient field extends across the diameter of the interior of the bore 12, which is typically on the order of 40 centimeters. Specifically, generating high strength gradients across such a large volume requires extremely high power amplifiers, which would impose significant additional expense for such systems.

Brief Summary Text (16):
Based on the foregoing discussion, what is needed is an MRI system that: eliminates relative patient to gradient field motion; is able to generate high strength gradients without creating a health risk; allows surgical access to a patient while being imaged; and is able to consistently depict nerve fascicles. The present invention provides a system that meets these as well as other criteria, as described in the following.

Brief Summary Text (18):
In accordance with the present invention, a focal magnetic resonance imaging system for imaging neural structures is provided. One aspect of the invention provides a splint-coil assembly that includes a splint and incorporated local gradient coils for generating high-strength gradients within the splint's interior, in which a body part, e.g., limb, of a patient is placed. The splint-coil assembly, and therefore the local gradient coils, are not fixed with respect to the polarizing field or main field generated by a main field coil, e.g., of a MR imaging machine. Rather, the splint conforms tightly around a patient's body part, so that the local gradient coils are fixed with respect to the patient. As a result, relative motion between the patient and the gradient fields produced by the local gradient coils is eliminated. The local gradient coils are positioned near the interior volume of the splint, so that the local gradient coils are in close proximity to the patient's body part. Therefore, the local gradient coils generate a gradient field within the relatively small interior of the splint, so that high-strength

gradients can be generated with a far smaller amount of drive power than would be required to irradiate the entire volume of a whole body imaging machine 10, and indeed can in many cases be generated with the amplifiers presently provided in whole-body imaging machines to achieve low gradients in a large volume. Further, other areas of the patient, e.g., chest and heart, are not exposed to the fields. Preferably, the local gradient coils includes a series of coils so that gradients can be produced along any direction within the splint.

Brief Summary Text (24):
In accordance with still further aspects of the present invention, a MRI method that consistently provides images depicting the fascicular structure of nerves is provided. The process is based on the discovery that the fascicular pattern of nerves is only clearly seen when the image plane formed by gradients fields is perpendicular to the long axis of the nerve. Specifically, the MRI method includes the step of creating an orthogonal alignment between the nerve to be imaged and the image plane. Then, with the orthogonal image plane, one of a variety of nerve enhancing MRI methods directed toward achieving relatively high signal intensity from the fascicles within a nerve is used to produce an image.

Brief Summary Text (25):
As will be appreciated from the foregoing brief summary, a focal MRI system for generating images of neural structures is provided. The system includes a splint-coil assembly that makes it possible to create localized high-strength field gradients, without exposing sensitive regions of the patient, e.g., chest and heart, to the high-strength gradients. Furthermore, because gradient coils are built into the splint, relative movement between the patient and the gradient fields is greatly reduced. The splint-coil assembly can be used in conjunction with a standard whole-body imaging machine 10.

Drawing Description Text (4):
FIG. 2 is a block diagram representation of the focal neurographic magnetic resonance imaging system provided by the present invention;

Detailed Description Text (2):
FIG. 2 is a block diagram representation of a focal magnetic resonance imaging system 20 formed in accordance with the invention for imaging neural structures such as nerves. The neurographic system 20 includes a control and analysis system 22, a polarizing system 24 and a splint-coil assembly 26. The control and analysis system 22 is coupled to the polarizing system 24, and the splint-coil assembly 26 to cause the polarizing system 24 and the splint-coil assembly 26 to generate magnetic and electromagnetic fields within a patient's body part that is to be imaged. In particular, in one preferred embodiment, the polarizing system 24 generates a polarizing magnetic field (referred to herein as the main field) and the splint-coil assembly 26 generates magnetic field gradients and radio-frequency (rf) electromagnetic excitation fields. The splint-coil assembly 26 senses the resonant response of the body part to the magnetic and electromagnetic fields, and the sensed resonant response is supplied to the control and analysis system 22 via an interface 38. The control and analysis system 22 processes the sensed resonant response to produce an image of a region of the body part.

Detailed Description Text (10):
In the preferred embodiment, the gradient coils 32 include a series of coils that allow producing gradient fields with any desired orientation and shape within the splint 28. As a minimum, the gradient coils 32 should allow simultaneously producing gradient fields along three orthogonal directions, i.e., along an X, Y, Z reference frame, and the orientation of the X, Y, Z reference frame should be completely controllable. This is particularly important for effective imaging of neural structures such as nerves. Various techniques, as provided in the original parent U.S. patent application Ser. No. 08/028,795, can be used to enhance neural structures such as nerves. One technique disclosed in the original parent U.S. patent application exploits the anisotropic quality of fluid diffusion in nerves to produce a nerve enhanced image by the use of diffusion gradients oriented perpendicular and parallel to the length of a nerve. Thus, for this technique the gradient coils must be able to generate diffusion gradients in various directions to follow the path of a nerve.

Detailed Description Text (36):
The particular preferred embodiment shown in FIG. 5 includes a pair of hard magnets 64 and 66 and a support frame 68 for holding the hard magnets 64, 66. The hard magnets 64, 66 can be formed of barium hexaferrite or some other high remanence, high retentivity material having high magnetic anisotropy. The hard magnets 64, 66 are held at spaced apart locations so that an

air gap or imaging region 62 is formed between the magnets 64, 66. The polarizations of the magnets 64, 66 are cooperatively oriented so that a homogenous magnetic field is formed in the imaging region 62, as shown generally by the flux lines. A patient's body part is first placed in the splint-coil assembly 26, and the splint-coil assembly 26 is then placed within the imaging region 62.

Detailed Description Text (38):
Furthermore, preferably, soft magnets 86, 88 are placed on the tips of the hard magnets 64, 66 at the air gap 62. The hard magnets 64, 66 are tapered toward the air gap 62 so as to maximize the field strength at the air gap 62 and to provide greater access to a surgeon or surgical robot to a patient's body part placed within the air gap 62. The soft magnets 86 and 88 are included to further improve the homogeneity and flux density of the magnetic field in the air gap 62. The soft magnets 86, 88 can be formed of a spinel ferrite. The soft magnet material should have a low magnetic retentivity and low magnetic anisotropy. The hard magnets may be optionally equipped with electrical coils for remagnetization between surgical procedures or during a long surgical procedure. Furthermore, the hard magnets 64, 66 may be replaced with super-conducting or nonsuper-conducting electrical coils, as long as access to the air gap 62 is not eliminated. Preferably, the magnets are coated with a thick, non-magnetic coating, for example, using one-half inch of carbon-fiber embedded epoxy or plastic.

Detailed Description Text (54):
FIG. 11 provides a flow diagram for generating MR images of nerves with nerve-orthogonal image planes. The execution of the process shown in FIG. 8 is controlled by the control and analysis system 22. First, the MRI system 20 is initialized, as indicated at the block 200. Next, at the block 202, a nerve enhancing image sequence is applied to a region of a patient. The resonant response of the patient is acquired and processed to generate an initial image of the region, as indicated at block 204. The image data is then processed to determine the orientation of a particular nerve, as indicated at the block 206 and as explained in greater detail later herein.

Detailed Description Text (69):
The neurographic MRI system described above is configured to generate images of small areas within a region of a patient. In order to reference the small image areas collected by this focal MRI system, it may be necessary to generate images of larger areas. By using a nerve enhancing imaging process as disclosed in the original parent U.S. patent application Ser. No. 08/028,795, nerves within an image region will appear brightly. The bright nerves can then be used as fiduciary markers that also appear in a smaller image, to align the smaller image within the larger image which provides an overall reference to the patient's body part. For example, a pre-operative MR image of the entire volume of a limb can be generated using a nerve enhancing imaging sequence with an MRI system that provides a larger imaging area. The nerves appearing in the images can then be used to map the small image regions into the image of the entire limb.

Other Reference Publication (1):
Howe, F.A., Filler, A.G., Bell, B.A. and Griffiths J.R.; "Magnetic Resonance Neurography"; Magnetic Resonance in Medicine 28:328-338 (1992).

Other Reference Publication (3):
M. Doran et al., "Magnetic Resonance: Perfusion and Diffusion Imaging," Neuroradiology 32:392-398 (1990).

Other Reference Publication (4):
M.E. Moseley et al., "Diffusion-weighted MR Imaging of Anisotropic Water Diffusion in CAT Central Nervous System," Radiology, 176:439-445 (Aug. 1990).

Other Reference Publication (5):
J.V. Hajnal et al., "MR Imaging of Anisotropically Restricted Diffusion of Water in the Nervous System: Technical Anatomic, and Pathologic Considerations," Journal Of Computer Assisted Tomography, 15:1-18 (Jan. 1991).

Other Reference Publication (8):
G.M. Bydder et al., "MR Imaging of Anisotropically Restricted Diffusion of Water in Tumors of the Central Nervous System", Book of Abstracts, Society of Magnetic Resonance in Medicine (1991).

Other Reference Publication (9):
J.S. Schoeniger et al., "NMR Microscopy of Single Neurons" Book of Abstracts, Society of Magnetic Resonance in Medicine (1991).

Other Reference Publication (10):
Douek et al., "Myelin Fiber Orientation Color Mapping," Book of Abstracts Society of Magnetic Resonance in Medicine, 919 (1991).

Other Reference Publication (11):
M.E. Moseley et al., "Anisotropy in Diffusion-Weighted MRI," Magnetic Resonance In Medicine, 19:321 (1991).

Other Reference Publication (12):
J.R. MacFall et al., "Pre- and Postmorten Diffusion Coefficients in Rat Neural and Muscle Tissues," Magnetic Resonance In Medicine 20:89-99 (1991).

Other Reference Publication (13):
M.E. Moseley et al., "Ultrafast Magnetic Resonance Imaging: Diffusion and Perfusion," Canadian Association Of Radiologists, 42(1):31-38 (Feb. 1991).

Other Reference Publication (15):
Chenevert et al., "Quantitative Diffusion Anisotropy in Rat Gliomas," Book of Abstracts, Society of Magnetic Resonance in Medicine, 787 (1991).

Other Reference Publication (17):
M.E. Moseley et al., "Acute Effects of Exercise on Echo-Planar T.sub.2 and Diffusion-Weighted MRI of Skeletal Muscle in Volunteers," Book of Abstracts, Society of Magnetic Resonance in Medicine, 108 (1991).

Other Reference Publication (18):
Neeman et al., "A Simple Method for Obtaining Cross-Term-Free Images for Diffusion Anisotropy Studies in NMR Microimaging," Book of Abstracts, Society of Magnetic Resonance in Medicine (1991).

Other Reference Publication (19):
J. Guy et al., "Fat Suppression MRI; Gd-DTPA Enhancement in Experimental Optic Neuritis," Book of Abstracts, Society of Magnetic Resonance in Medicine, 913 (1991).

Other Reference Publication (20):
G. Sze, "Recent Advances in Spinal Magnetic Resonance Imaging," Canadian Association of Radiologists Journal, 42(3):190-198 (Jun. 1991).

Other Reference Publication (21):
Haase et al., "NMR Chemical Shift Selective Imaging", 30 Phys. Med. Biol. 341-344 (1985).

Other Reference Publication (35):
P.B. Roemer et al., "The NMR Phased Array," Magnetic Resonance In Medicine 16:192-225 (1990).

Other Reference Publication (36):
C.E. Hayes et al., "Volume Imaging with MR Phased Arrays," Magnetic Resonance In Medicine 18:309-319 (1991).

Other Reference Publication (37):
F.G. Shellock et al., "Kinematic Magnetic Resonance Imaging of the Joints: Techniques and Clinical Applications," Magnetic Resonance Quarterly, 7(2):104-135 (1991).

CLAIMS:

1. A splint-coil assembly for use with a magnetic resonance imaging coil of the type that generates a main magnetic field in which the magnetic flux of said main magnetic field is stationary and extends in a fixed direction relative to the three mutually orthogonal axes of a three-dimensional spatial reference system, said splint-coil assembly including:

(a) a conformable wall that defines an interior region adapted to receive a body part of a patient for magnetic resonance imaging of the body part when said splint-coil assembly is positioned within said main magnetic field, said conformable wall being conformable so that the splint-coil assembly fits snugly about the body part; and

(b) a gradient magnetic coil formed about said conformable wall for generating a gradient magnetic field within said interior region, said gradient magnetic coil being secured to said conformable wall so that said gradient magnetic coil is fixed with respect to the body part, thereby substantially eliminating relative motion between said gradient magnetic field generated by said gradient magnetic coil and the body part;

said splint-coil assembly being sized and configured for placement in said main magnetic field and being positionable at a plurality of selected orientations relative to each of the three mutually orthogonal axes of said three-dimensional spatial reference system.

8. A splint-coil assembly for use with a magnetic resonance imaging coil of the type that generates a main magnetic field in which the magnetic flux of the main magnetic field is stationary and extends in a fixed direction relative to the three mutually orthogonal axes of a three-dimensional spatial reference system, said splint-coil assembly comprising:

(a) a conformable wall that defines an interior region adapted to receive a body part of a patient for magnetic resonance imaging of the body part when said splint-coil assembly is positioned within said main magnetic field, said conformable wall of said splint-coil assembly being conformable so that said splint-coil assembly fits snugly about the body part of the patient;

(b) at least one magnetic coil formed about said conformable wall for creating magnetic fields within said interior region of said splint-coil assembly, said at least one magnetic coil being secured to said conformable wall so that said at least one magnetic coil is fixed with respect to the body part, thereby substantially eliminating relative motion between the magnetic fields produced by said at least one magnetic coil and the body part;

wherein said splint-coil assembly is sized and shaped for positioning said splint-coil assembly at a selected orientation relative to the three orthogonal axes of said spatial reference system and said magnetic resonance imaging coil; and wherein,

(c) said splint-coil assembly further comprises stabilization means for stabilizing the splint-coil assembly at said selected orientation relative to said the three orthogonal axes of said three-dimensional spatial reference system and said magnetic resonance imaging coil, said stabilization means including a support frame and a plurality of extendible rods that are coupled at one end to said support frame and at another end to said splint-coil assembly to collectively form triangulated bracing.

9. The splint-coil assembly of claim 8 wherein said splint-coil assembly is for use with a whole body magnetic resonance imaging system of the type that includes a main field bore and a stretcher that is slidable into the main field bore with a patient on said stretcher with a body part inserted in said splint-coil assembly and wherein said support frame of said stabilization apparatus is mounted to said stretcher.

13. A splint-coil assembly for use with a magnetic resonance imaging coil of the type that generates a main magnetic field in which the magnetic flux of the main magnetic field is stationary and extends in a fixed direction relative to the three mutually orthogonal axes of a three-dimensional spatial reference system, said splint-coil assembly comprising:

(a) a conformable wall that defines an interior region adapted to receive a body part of a patient for magnetic resonance imaging of the body part when said splint-coil assembly is positioned within said main magnetic field, said conformable wall of said splint-coil assembly being conformable so that said splint-coil assembly fits snugly about the body part of the patient;

(b) at least one magnetic coil formed about said conformable wall for creating magnetic fields within said interior region of said splint-coil, said at least one magnetic coil being secured to said conformable wall so that said at least one magnetic coil is fixed with respect to the body part, thereby substantially eliminating relative motion between the magnetic fields

produced by said at least one magnetic coil and the body part;

wherein said splint-coil assembly is sized and shaped for positioning said splint-coil assembly at a selected orientation relative to the three orthogonal axes of said spatial reference system and said magnetic resonance imaging coil; and

(c) wherein said splint-coil assembly further comprises means for determining the orientation of said magnetic fields within said interior of said splint-coil assembly relative to said predetermined orientation of said main magnetic field.

16. A splint-coil assembly for use with a magnetic resonance imaging coil of the type that generates a main magnetic field in which the magnetic flux of the main magnetic field is stationary and extends in a fixed direction relative to the three mutually orthogonal axes of a three-dimensional spatial reference system, said splint-coil assembly comprising:

(a) a conformable wall that defines an interior region adapted to receive a body part of a patient for magnetic resonance imaging of the body part when said splint-coil assembly is positioned within said main magnetic field, said conformable wall being conformable so that the splint-coil assembly fits snugly about the body part;

(b) a gradient magnetic coil formed about said conformable wall for generating a gradient magnetic field within said interior region, said gradient magnetic coil being secured to said conformable wall so that said gradient magnetic coil is fixed with respect to the body part, thereby substantially eliminating relative motion between said magnetic gradient field generated by said gradient magnetic coil and the body part;

wherein said splint-coil assembly is sized and shaped for positioning said splint-coil assembly at a selected orientation relative to the three orthogonal axes of said spatial reference system and said magnetic resonance imaging coil; and wherein;

said splint-coil further comprises means for determining the orientation of said magnetic fields within said interior of said splint-coil assembly relative to said predetermined orientation of said main magnetic field.

19. A splint-coil assembly for use with a magnetic resonance imaging coil of the type that generates a main magnetic field in which the magnetic flux of the main magnetic field is stationary and extends in a fixed direction relative to the three mutually orthogonal axes of a three-dimensional spatial reference system, said splint-coil assembly comprising:

(a) an exterior shell and an inflatable liner that defines a conformable wall and is surrounded by said exterior shell, said conformable wall defining an interior region adapted to receive a body part of a patient for magnetic resonance imaging of the body part when said splint-coil assembly is positioned within said main magnetic field, said inflatable liner of said splint-coil assembly being filled under pressure with a paramagnetically doped fluid to fit said splint-coil assembly snugly about the body part of the patient;

(b) at least one magnetic coil formed about said conformable wall for creating magnetic fields within said interior region of said splint-coil, said at least one magnetic coil being secured to said conformable wall so that said at least one magnetic coil is fixed with respect to the body part, thereby substantially eliminating relative motion between the magnetic fields produced by said at least one magnetic coil and the body part;

said splint-coil assembly being of a size and shape for positioning said splint-coil assembly at a selected orientation relative to the three orthogonal axes of said spatial reference system and said magnetic resonance imaging coil.

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1. Document ID: US 20070092432 A1

L16: Entry 1 of 10 File: PGPB Apr 26, 2007

PGPUB-DOCUMENT-NUMBER: 20070092432
PGPUB-FILING-TYPE:
DOCUMENT-IDENTIFIER: US 20070092432 A1

TITLE: Thermally exfoliated graphite oxide

PUBLICATION-DATE: April 26, 2007

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY
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Aksay; Ilhan A.	Princeton	NJ	US
Adamson; Douglas	Skillman	NJ	US
Abdala; Ahmed	Suez		EG

US-CL-CURRENT: 423/448

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KWIC | Draw Desc | Image

2. Document ID: US 20050019668 A1

L16: Entry 2 of 10 File: PGPB Jan 27, 2005

PGPUB-DOCUMENT-NUMBER: 20050019668
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20050019668 A1

TITLE: Ionic conduction structural member, secondary battery and method of producing same

PUBLICATION-DATE: January 27, 2005

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY
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US-CL-CURRENT: 429/317; 429/231.4, 429/231.95, 521/27

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KWIC | Draw Desc | Image

☐ 3. Document ID: US 20030155667 A1

L16: Entry 3 of 10 File: PGPB Aug 21, 2003

PGPUB-DOCUMENT-NUMBER: 20030155667
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20030155667 A1

TITLE: Method for making or adding structures to an article

PUBLICATION-DATE: August 21, 2003

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY
Devoe, Robert J	Oakdale	MN	US
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Fleming, Patrick R	Lake Elmo	MN	US
Kalweit, Harvey W	Burnsville	MN	US

US-CL-CURRENT: 264/1.27; 264/1.31, 264/16, 264/482, 264/494

Full	Title	Citation	Front	Review	Classification	Date	Reference	Sequences	Attachments	Claims	KWIC	Draw Desc	Image

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☐ 4. Document ID: US 20030002132 A1

L16: Entry 4 of 10 File: PGPB Jan 2, 2003

PGPUB-DOCUMENT-NUMBER: 20030002132
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20030002132 A1

TITLE: Photochromic electrophoretic ink display

PUBLICATION-DATE: January 2, 2003

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NAME	CITY	STATE	COUNTRY
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US-CL-CURRENT: 359/296

Full	Title	Citation	Front	Review	Classification	Date	Reference	Sequences	Attachments	Claims	KWIC	Draw Desc	Image

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☐ 5. Document ID: US 7229927 B1

L16: Entry 5 of 10 File: USPT Jun 12, 2007

US-PAT-NO: 7229927
DOCUMENT-IDENTIFIER: US 7229927 B1

TITLE: Semiconductor processing silica soot abrasive slurry method for integrated circuit microelectronics

DATE-ISSUED: June 12, 2007

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Darcangelo; Charles M.	Corning	NY		US
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Stevens; Harrie J.	Corning	NY		US
Ukrainczyk; Ljerka	Painted Post	NY		US

US-CL-CURRENT: 438/693; 257/E21.23, 257/E21.304

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw Desc | Image

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6. Document ID: US 6517618 B2

L16: Entry 6 of 10 File: USPT Feb 11, 2003

US-PAT-NO: 6517618
DOCUMENT-IDENTIFIER: US 6517618 B2

TITLE: Photochromic electrophoretic ink display

DATE-ISSUED: February 11, 2003

INVENTOR-INFORMATION:

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Wojtyk; James	Ottawa			CA
Buncel; Erwin	Kingston			CA

US-CL-CURRENT: 106/31.16; 106/31.32, 106/31.49, 106/31.64, 106/31.78

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw Desc | Image

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7. Document ID: US 5811971 A

L16: Entry 7 of 10 File: USPT Sep 22, 1998

US-PAT-NO: 5811971
DOCUMENT-IDENTIFIER: US 5811971 A

TITLE: Magnetic sensor and magnetic field sensing method using said magnetic sensor based on impedance changes of a high frequency excited conductor

DATE-ISSUED: September 22, 1998

INVENTOR-INFORMATION:

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Toshima; Tomoyuki	Tokorozawa			JP

US-CL-CURRENT: 324/244; 324/250, 324/260, 360/110

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw Desc | Image

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☐ 8. Document ID: US 5734267 A

L16: Entry 8 of 10 File: USPT Mar 31, 1998

US-PAT-NO: 5734267
DOCUMENT-IDENTIFIER: US 5734267 A
**** See image for Certificate of Correction ****

TITLE: Magnetic head, magnetic recording method using the magnetic head, and magnetic field sensing method using the magnetic head based on impedance changes of a high frequency excited conductor

DATE-ISSUED: March 31, 1998

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
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US-CL-CURRENT: 324/244; 324/250, 324/260, 360/110

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw Desc | Image

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☐ 9. Document ID: US 5729188 A

L16: Entry 9 of 10 File: USPT Mar 17, 1998

US-PAT-NO: 5729188
DOCUMENT-IDENTIFIER: US 5729188 A

TITLE: Homogeneous field magnet with at least one pole plate to be mechanically aligned

DATE-ISSUED: March 17, 1998

INVENTOR-INFORMATION:

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US-CL-CURRENT: 335/298; 324/319, 335/297

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw Desc | Image

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☐ 10. Document ID: US 5705926 A

L16: Entry 10 of 10 File: USPT Jan 6, 1998

US-PAT-NO: 5705926
DOCUMENT-IDENTIFIER: US 5705926 A
**** See image for Certificate of Correction ****

TITLE: Magnetic sensor and magnetic field sensing method of using same based on impedance changes of a high frequency supplied conductor

DATE-ISSUED: January 6, 1998

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Senda; Masakatsu	Mito			JP
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Toshima; Tomoyuki	Tokorozawa			JP

US-CL-CURRENT: 324/244; 324/207.13, 324/249, 324/250, 324/260, 360/110

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw Desc | Image

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Clear | Generate Collection | Print | Fwd Refs | Bkwd Refs | Generate OACS

Term	Documents
RESIST$4	0
RESIST	575696
RESISTA	16501
RESISTAA	12
RESISTAAC	8
RESISTAACC	2
RESISTAACE	190
RESISTAACP	1
RESISTAACQ	1
RESISTAAC6	1
RESISTAAD	1
(L15 AND (RESIST$4)).PGPB,USPT,USOC,EPAB,JPAB,DWPI,TDBD.	10

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L16: Entry 9 of 10 File: USPT Mar 17, 1998

DOCUMENT-IDENTIFIER: US 5729188 A
TITLE: Homogeneous field magnet with at least one pole plate to be mechanically aligned

Brief Summary Text (3):
Homogeneous field magnets are needed to generate primary magnetic fields in systems for nuclear resonance tomography (nuclear magnetic resonance tomography, magnetic resonance imaging or magnetic resonance spectroscopy). The magnetic field of such primary field magnets must be sufficiently homogeneous within an imaging or examination range (active volume) and generate a predetermined magnetic induction B.sub.o there. For magnetic inductions B.sub.o >0.5 T, superconductive coil systems are generally provided. In contrast, lower magnetic inductions (B.sub.o <0.5 T) can also be generated with standard conductive coils or permanent magnets. The latter are formed, in many cases, as pole shoe magnets with an iron yoke in the form of a "C". The active volume with the required field homogeneity then lies between the pole surfaces of the opposite pole shoes.

Brief Summary Text (4):
The field homogeneity which can initially be achieved in the active volume is not sufficient for the requirements of magnetic resonance tomography due to unavoidable production tolerances. Therefore, there has to be a correction possibility in the finished magnet, in order to be able to successively reduce variations of the field homogeneity. Such a correction may be made by means of an alternating sequence of field measurements and field corrections (shimming).

Brief Summary Text (6):
In order to be able to align such profiled pole plates relative to one another with sufficient accuracy, and to correct field errors, at least one of the pole plates is not attached directly to the iron yoke carrying a magnetic flux, in the homogeneous field magnet as is evident from the reference DE-OS 3737133 mentioned initially. Rather, the profiled pole plate is separated from a base part of the pole shoe facing the yoke by a narrow correction air gap, where it is structured so it can be tilted and/or bent by means of special setting devices. The air gap acts to homogenize the field, as a magnetic series resistor, in that it equalizes flux density non-homogeneity in flux conducting parts of the pole shoe during the flux transition into the pole plate in each case.

Brief Summary Text (8):
The present invention further improves and simplifies the mechanical field correction possibilities of conventional homogeneous field magnets. Only a relatively slight magnetic flux density is supposed to be present in the plane of the pole plate in order to allow good diffusion of additional magnetic flux. These are produced, in particular, by pulsed gradient fields for magnetic resonance tomography. Non-linearities of these gradient fields are supposed to be avoided to a great extent.

Detailed Description Text (2):
Parts of the present invention that are well known to those familiar with conventional homogeneous field magnets and their use in magnetic resonance tomography will not be explained in great detail. The magnet of the present invention is structured as a pole shoe magnet, demonstrating the following general structural characteristics:

Detailed Description Text (9):
Between the pole surfaces 10a and 11a of the two pole shoes 10 and 11, which lie at least essentially parallel to the plane of symmetry E at a predetermined distance A, there is an intermediate space or active volume N. In this active volume, a magnetic field which is sufficiently homogeneous for magnetic resonance tomography is supposed to prevail. This magnetic field is produced by the two exciter coils 7 and 8. With normally conductive coils,

magnetic inductions B.sub.o (indicated with arrow lines) can be achieved in the active volume. The indicators are limited by the saturation magnetization of the yoke material and are thus below 0.5 T, for example.

Detailed Description Text (10):
Each of the pole shoes 10 and 11 contains a base part 10b and 11b, respectively, conducting the magnetic field and connected with the yoke 3 via the cores 4 and 5, respectively. Each base part 10b and 11b has a flat, free surface except for its edge area. This edge area has a bead-like edge piece 10c or 11c which reduces the distance A. These ring-shaped edge pieces provide field correction at the outer edge of the pole shoes and are therefore also designated as "field correction rings." In an inner (central) area of at least one of the pole shoes, surrounded by these edge pieces, but preferably in both pole shoes, a special pole plate 10d or 11d is arranged. Each pole plate is supposed to be separated from its assigned base part by a narrow correction air gap. In the figure, the correction gap located between the base part 10b and the pole plate 10d is designated as 14. Correspondingly, the correction gap 15 lies between the base part 11b and the pole plate 11d. In general, there are gradient coils (not shown in the figure) in the immediate vicinity of the surfaces 10a and 11a of the pole plates 10d and 11d respectively which face the active volume area N, to generate the pulsed gradient fields required for magnetic resonance tomography.

Detailed Description Text (12):
In the cross-section through a part of the pole shoe 11 shown in FIG. 2, the base part 11b, with an essentially trapezoid cross-sectional area and a stepped surface 16, can be seen. This part 11b represents the extension of a ferromagnetic core (5) (not shown in the figure), for example in cylindrical shape, which is surrounded by a normal conductive exciter coil (8) (not shown in the figure). If necessary, this core and the base part 11b can form a common component. The surface 16 of the base part 11b is divided into a middle surface part 16a corresponding to a middle, central pole area 17a, and an outer surface part 16b corresponding to an edge area 17b. Between these two areas there is a step 18, so that an edge piece 11c of the base part, for example with a rectangular cross-sectional area, results. The height h of the edge piece 11c, i.e. the distance between the planes of the middle surface part 16a and the outer surface part 16b at the step 18, can amount to between 20 and 50 mm, for example approximately 40 mm. The radial width b of the edge piece 11c or the outer surface part 16b generally lies between 40 and 80 mm, for example approximately 60 mm. The cross-sectional area of the edge piece 11c can also have a different shape, for example trapezoidal. The edge piece can be attached to the base part 11b as a separate component, for example. In this case, the edge piece may be produced from a material with magnetic properties that are different from those of the remaining base part. According to the embodiment shown, however, it is assumed that the edge piece 11c forms a common molded piece with the base part 11b.

Detailed Description Text (13):
In the middle, central pole area 17a, the pole plate 11d is arranged separated from the surface part 16a by a narrow correction air gap 15. A radial gap with a width w is supposed to remain between the outside edge of the plate and the edge piece 11c. The gap width w generally lies approximately between 2 and 20 mm. In general, the pole plate 11d should take up less than 85% of the entire surface 16 of the pole shoe 11. For a base part with rotational symmetry with regard to a line (axis) M through its center, the radius r of the pole plate 11d may be defined by: r<0.9.multidot.R, where R is the maximum outside radius of the base part 11b or its edge piece 11c. Setting devices for fixation as well as for tilting and/or bending of the pole plate 11d are sufficiently known (see reference DE-OS 3737133 as mentioned). Therefore these devices were not shown in FIG. 2. It is advantageous if the pole 11d has a rectangular cross-sectional area, being structured to be relatively thin. Thus, its constant thickness s lies between 3 mm and 30 mm, preferably between 5 mm and 15 mm. It is advantageous if a magnetic material with great relative permeability .mu..sub.r and great flux carrying capacity B.sub.max is selected for the plate 11d, at least in part. Thus, for example, a solid, magnetically isotropic plate made of a Si--Fe alloy with .mu..sub.r .apprxeq.4000 and B.sub.max .apprxeq.1.6 T can be used. This material has an electrical conductivity of approximately 2.5.multidot.10.sup.6 S/m. Corresponding pole plates are particularly easy to manufacture.

Detailed Description Text (15):
Furthermore, as was assumed for the embodiment according to FIG. 2, the pole plate 11d can have a layer structure of two layers 22a and 22b with approximately the same thickness, where different materials are selected for these layers. The first layer 22a, which faces the correction air gap 15, can be produced from one or more electric sheets of a Si--Fe alloy, each

1 to 5 mm thick, for example, so that sufficient flexibility of the overall structure is guaranteed. In contrast, the second layer 22b, which faces the active volume N, can consist, for example, of a soft-magnetic ferrite or a plastic-bonded iron powder. With a relative permeability .mu..sub.r of approximately 1000 and flux carrying capacity B.sub.max of approximately 0.4 T to 0.5 T, it is possible to guarantee only slight electrical conductivity of this layer, in an advantageous manner. The first, highly permeable layer 22a provides good primary field homogeneity. The second layer 22b carries the additional magnetic flux, which is caused during the pulse increase time of the gradient current of the gradient coils required for magnetic resonance tomography, for short periods of time. These gradient coils, not shown in FIG. 2, are located, in a known manner, in the immediate vicinity of the surface 23 of the layer 22b facing the active volume N. With the layer structure shown, the gradient field can be switched on almost without delay, in an advantageous manner. This is because the magnetic diffusion processes which causes the pulse shape to loop, such as they occur in the case of a pole plate of purely ferromagnetic and electrically conductive material, are essentially suppressed. This characteristic can be seen in the diagram of FIG. 3. In this diagram, the time t (in ms) is entered in the direction of the abscissa, and the gradient field intensity G (in mT/m) to be measured is entered in the direction of the ordinate, for a specific embodiment. The curve designated as A relates to a pole plate of solid electric sheet, while the curve designated as B relates to a pole plate 11d with the structure of the layers 22a and 22b, with a different magnetic behavior and a different electrical conductivity, as shown in FIG. 2 and explained above. Furthermore, the time progression of a pulse of the gradient current I.sub.g is indicated with a broken line. As shown in FIG. 3 it has increased to its maximum value in about 0.5 ms. With this, the amount of this current in the ordinate direction is given in arbitrary units. As is evident from a comparison of the curves A and B, the stationary value of the gradient field intensity is reached significantly quicker when the pole plate 11d has a layered structure (Curve B) than when the pole plate is a uniformly magnetic material which is electrically conductive (Curve A). In the case of the latter pole plate, it is necessary to wait significantly longer to use its gradient field since the transient time of the pulse is significantly longer.

CLAIMS:

3. A homogeneous field magnet according to claim 2, wherein the layer of the pole plate which faces the active volume has relatively low electrical conductivity.

12. A homogeneous field magnet according to claim 11, wherein the layer of the pole plate which faces the active volume has relatively low electrical conductivity.

21. A homogeneous field magnet according to claim 20, wherein the layer of the pole plate which faces the active volume has relatively low electrical conductivity.

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L16: Entry 10 of 10 File: USPT Jan 6, 1998

DOCUMENT-IDENTIFIER: US 5705926 A

**** See image for Certificate of Correction ****

TITLE: Magnetic sensor and magnetic field sensing method of using same based on impedance changes of a high frequency supplied conductor

Abstract Text (1):
In a magnetic field sensing method in accordance with the invention of the present application, a magnetic sensor comprising a conductor and at least one magnetic material provided on any of the surfaces of this conductor, is employed. This magnetic sensor is disposed in the vicinity of an external magnetic field which is to be sensed, and by means of supplying a high frequency current to this conductor, the impedance of the conductor changes in accordance with the external magnetic field, and based on this, the external magnetic field is sensed.

Brief Summary Text (9):
A magnetoresistance effect-type head (hereinbelow referred to as an "MR head") has been proposed as a magnetic head capable of signal reproduction even in cases in which the strength of the magnetic field of the medium is low. FIG. 25 is an angled view showing an example of the structure of a conventional MR head. In FIG. 25, the MR head comprises a magnetoresistance element (hereinbelow referred to as an "MR element") 7, measurement lead wires 8a and 8b, DC bias conductor 9, and DC bias current supply lead wires 10a and 10b. This MR head is a head dedicated to reproduction.

Brief Summary Text (10):
In the state in which a constant DC current is passed between measurement lead wires 8a and 8b, the MR head shown in FIG. 25 expresses the change in the electrical resistance value of MR element 7, originating in the changes in strength of the medium magnetic field generated by the magnetic recording medium, as changes in voltage between measurement lead wires 8a and 8b, and thus reproduces the signal.

Brief Summary Text (11):
Conventionally, MR heads were widely employed which used the anisotropic magnetoresistance effect (hereinbelow referred to as the "MR effect") of ferromagnetic materials. The changes in the resistance value R of the MR element 7 resulting from the MR effect are expressed by Formula (1).

Brief Summary Text (12):
In Formula (1), R.sub.0 indicates the resistance value of the MR element 7 when the direction of magnetization of MR element 7 and the direction of the current are perpendicular, .DELTA.R indicates the difference in resistance between resistance value R.sub.0 and the resistance value of MR element 7 when the direction of magnetization of MR element 7 and the direction of the current are parallel, and .theta. indicates the angle between the direction of magnetization of the MR element 7 and the direction of the current. Furthermore, the SN ratio of the MR head is expressed by the resistance change ratio .DELTA.R/R.sub.0 (hereinbelow referred to as the "MR ratio").

Brief Summary Text (14):
When alloys such as NiFe, NiCo, and NiCu, which are representative of ferromagnetic materials which have been conventionally employed in the magnetoresistance sensor (hereinbelow referred to as an "MR sensor") of MR heads or the like, were employed, the MR ratio was low, at a level of a few percent in all cases (at room temperature), and furthermore, as regards the resistance change .DELTA.R itself, only a small value was obtainable. Accordingly, the SN ratio and sensitivity of an MR sensor employing such alloys was insufficient.

Brief Summary Text (15):
Furthermore, the MR element 7, which was employed as a sensor element in the conventional MR head described above, was capable of conversion in only one direction, from magnetic field to an electrical resistance value, as a result of the operational principle thereof, and this was thus not reversible. Accordingly, such conventional MR heads were restricted to use as reproduction-only heads, and could not be used as recording heads.

Brief Summary Text (16):
Furthermore, as is clear from Formula (1), since the MR effect is symmetrical with respect to magnetic field inversion, in order to sense the polarity of an external magnetic field, it is necessary to move the operational point of the MR element and give asymmetry to the characteristics thereof by means of applying a DC bias magnetic field to the MR element. A DC bias magnetic field application method has been proposed in which, as shown in FIG. 25, a DC bias conductor 9 is further disposed so as to adjoin MR element 7 through the medium of an insulator (not depicted in the Figure), a DC bias current is caused to flow to the DC bias conductor 9, and the magnetic field generated at the MR element by the DC bias current is employed. However, in this method, there are problems in that the number of structural components increase, and the design and production of the parts becomes complex.

Brief Summary Text (17):
Recently, a phenomenon has been discovered in which, in a Fe/Cr multi-layer film, the MR ratio is approximately 50% (this is termed the "giant magnetoresistance effect") (M. N. Baibich, et al., Phys. Rev. Lett., Vol. 61, pp 2472.about.2475, 1988); however, because the operating temperature is extremely low, at 4.2K, and it is necessary to apply a strong magnetic field of 20 kOe, the effect is not suitable for practical application. Furthermore, a large hysteresis is exhibited in the dependence of the resistance on the external magnetic field, so that there is a problem in that the accuracy of the sensing of the signal is low.

Brief Summary Text (19):
Magnetic reproduction apparatuses are disclosed in Japanese Patent Application, Second Publication, No. Hei 3-23962, and Japanese Patent Application, First Publication, Laid-Open No. Sho 60-29901. These magnetic reproduction apparatuses operate according to a principle in which changes in an external magnetic field are converted into changes in the magnetic permeability of a magnetic material, these changes in magnetic permeability are converted into changes in impedance in a measurement coil, and these changes in impedance are converted into changes in the voltage between both ends of a tuning circuit, and thereby, the variations in an external magnetic field are sensed. In such magnetic reproduction apparatuses, because a tuning circuit is employed, it is necessary that the resonance frequency thereof be brought into conformity with the magnetic resonance frequency of the magnetic material; however, in order to do this, the capacity of the condenser used for tuning must be adjusted. In the case in which the tuning state of the tuning circuit is displaced, the sensing sensitivity with respect to the external magnetic field and the like changes rapidly, so that in order to ensure stability and reliability of the apparatus, it is necessary to control the tuning with high accuracy, and there is a problem in that operations and control become difficult. Furthermore, it is necessary to increase the Q of the tuning circuit in order to increase the sensing sensitivity with respect to the external magnetic field; however, in this case, the tuning circuit has a narrow band. In addition, when the tuning circuit acquires a narrow band, the output voltage value is dependent on the frequency of the magnetic field which is sensed, and this causes a problem from the point of view of the stability and reliability of the apparatus. In such a case, the output voltage of the tuning circuit becomes smaller when the signal becomes higher, so that the band width in which signals can be sensed is restricted. For example, in high-definition video, the signal frequency is on the level of 80 MHz, so that in the case in which this signal is sensed by means of amplitude modulation, a band width of 160 MHz or more is necessary. Furthermore, in magnetic recording apparatuses having high recording density, the realization of which is predicted for the future, it is predicted that a band width of 100.about.200 MHz will be necessary; however, a signal having this type of broad band cannot be reproduced by means of the apparatuses disclosed in the documents described above.

Brief Summary Text (23):
Accordingly, the present invention is characterized in that a magnetic sensor comprising a conductor and at least one magnetic material provided on any of the faces of the conductor is disposed in the vicinity of an external magnetic field which is to be sensed, a high frequency current is supplied to the conductor, and based on the changes in the impedance in the

conductor in accordance with this external magnetic field, the external magnetic field is sensed.

Brief Summary Text (24):
Furthermore, the present invention is characterized in that a magnetic sensor, comprising a conductor, and at least one magnetic material which is provided so as to enclose the periphery of the conductor, and is provided with a gap at a portion of the magnetic circuit formed by this magnetic material which faces an external magnetic field to be sensed, is disposed in the vicinity of an external magnetic field which is to be sensed, a high frequency current is supplied to the conductor, and based on changes in the impedance of the conductor as a result of the external magnetic field, the external magnetic field is sensed.

Brief Summary Text (25):
Furthermore, the present invention is characterized in that a ring-type inductive magnetic sensor, comprising a magnetic core, a coil wound around this magnetic core, and at least one conductor which is provided within the magnetic core, is disposed in the vicinity of an external magnetic field which is to be sensed, a high frequency current is supplied to the conductor, and based on changes in the impedance of the conductor resulting from the external magnetic field, the external magnetic field is sensed.

Brief Summary Text (26):
Furthermore, the present invention is characterized in being provided with: a magnetic sensor, comprising a conductor, and at least one magnetic material provided on any of the surfaces of the conductor; a high frequency generator which supplies a high frequency current to the conductor; and a wave detector which detects the changes in voltage amplitude at both ends of the conductor.

Brief Summary Text (27):
Furthermore, the present invention is characterized in being provided with: a magnetic sensor, comprising a conductor, and at least one magnetic material which is provided so as to enclose the periphery of the conductor and which is provided with a gap at the portion of the magnetic circuit formed by this magnetic material which faces the external magnetic field which is to be sensed; a high frequency generator which supplies a high frequency current to the conductor; and a wave detector which detects changes in the voltage amplitude at both ends of the conductor.

Brief Summary Text (28):
In addition, the present invention is characterized in being provided with: a ring-type inductive magnetic sensor, comprising a magnetic core, a coil wound around this magnetic core, and at least one conductor which is provided within the magnetic core; a high frequency generator which supplies high frequency current to the conductor; and a wave detector which detects the changes in voltage amplitude at both ends of the conductor.

Brief Summary Text (30):
Furthermore, the conductor, or the coil, is combined with a conductor for DC bias, so that in the case in which a magnetic field polarity sensing function is to be provided, this is advantageous in that the component structure is simple. Furthermore, in comparison with the giant magnetoresistance effect, room temperatures and low magnetic field response are possible, and there is small hysteresis, so that there are advantages in that the measurement system is simple, the sensitivity is high, and the reliability is high.

Drawing Description Text (50):
FIG. 19 shows an example of the dependency characteristics of the peak-to-peak voltage V between conductor electrodes 79a and 79b with respect to an external magnetic field H.sub.EX in the magnetic field sensing apparatus in accordance with the Third Embodiment of the present invention.

Detailed Description Text (5):
In FIG. 1A, the magnetic field sensing apparatus comprises a magnetic sensor 50, a high frequency generator 51, and a wave detector 52 which converts changes in voltage amplitude to changes in voltage. In magnetic sensor 50, a plurality of magnetic materials 55 are formed on the surface of a conductor 54, possessing a pair of electrodes 53a and 53b at the ends thereof. As explained below, when a DC bias current is run through conductor 54, wave detector 52 is provided with a function to cut the DC current in order to cancel the DC bias current from the

signal to be detected, during the process of detection. FIG. 1B is a cross sectional view taken along the line A--A' in FIG. 1A. In FIG. 1B, the magnetic materials 55 are provided directly on the conductor 54. The impedance z(f) at a given frequency f of the magnetic sensor 50 having this type of structure is expressed by Formula (2) below.

Detailed Description Text (6):
In Formula (2), Z.sub.0 (f) represents the impedance originating in conductor 54 itself, while .DELTA.Z.sub.mag (f) represents the amount of increase in the impedance in conductor 54 resulting from the existence of magnetic materials 55 on the surface thereof; this arises as a result of the reflection and absorption of the high frequency magnetic field in magnetic materials 55. In this case the term "high frequency magnetic field" refers to a high frequency magnetic field which is generated circumferentially around conductor 54 when a high frequency current is supplied to conductor 54 from generator 51. This high frequency magnetic field is reflected and absorbed in magnetic materials 55, resulting in the generation of .DELTA.Z.sub.mag (f). Impendance Z.sub.0 (f) exhibits almost no dependence on frequency within a range of frequencies less than or equal to a few GHz, and maintains a constant value. The amount of increase .DELTA.Z.sub.mag (f) in the impedance has the relationship to the relative magnetic permeability .mu..sub.r (f) of magnetic materials 55 which is shown in Formula (3) below.

Detailed Description Text (9):
When the strength of the external magnetic field H.sub.EX which is applied to the magnetic materials 55 is increased, the value of the relative magnetic permeability .mu..sub.r (f) is reduced, and when the strength of the external magnetic field H.sub.EX reaches a sufficiently large value in comparison with the anisotropic magnetic field of magnetic materials 55, the value of the relative magnetic permeability .mu..sub.r (f) finally reaches 0. The SN ratio of the magnetic sensor 50 is expressed by the voltage change ratio .DELTA.V/V(0) of the peak-to-peak voltage between electrodes 53a and 53b. This voltage change ratio .DELTA.V/V(0) is expressed by Formula (5) below. ##EQU1##

Detailed Description Text (10):
In formula (5), V(0) represents the peak-to-peak voltage between electrodes 53a and 53b when an external magnetic field H.sub.EX is not applied, while V(H) indicates the peak-to-peak voltage between electrodes 53a and 53b when magnetic materials 55 are saturated; .DELTA.V is given by [V(0)-V(H)]. In Formula (5), the value of impedance Z.sub.0 (f) is small, and the amount of increase .DELTA.Z.sub.mag (f) in the impedance becomes a very large value in high frequency regions, so that magnetic sensor 50 possesses an extremely large SN ratio. Furthermore, it is possible te select a material for use as magnetic materials 55 which has a low anisotropic magnetic field and has small hysteresis, so that it is possible to increase sensitivity and sensing accuracy.

Detailed Description Text (11):
In this way, the magnetic sensor 50 has the following operational principle: when a high frequency current is applied to conductor 54 by high frequency generator 51 through the medium of electrodes 53a and 53b, the impedance of the conductor 54 changes in accordance with the external magnetic field H.sub.EX, and based on this, the changes in the external magnetic field H.sub.EX are sensed as changes in voltage amplitude. These changes in voltage amplitude are converted into changes in voltage by means of wave detector 52. Even if a plurality of pairs of electrodes 53a and 53b are provided for high frequency current application and voltage measurement, similar effects can be obtained. Furthermore, similar effects can be obtained even if there is only one magnetic material 55.

Detailed Description Text (12):
FIGS. 2A.about.2I show, in schematic form, other structures of the magnetic sensor 50; they correspond to cross sectional views taken along a line A-A' in FIG. 1A, respectively. The magnetic materials may be formed directly on the surface of the conductor, or through the medium of a non-magnetic insulator; FIG. 2A shows a structure in which magnetic material 55 is provided on conductor 54 through the medium of non-magnetic insulator 56. FIG. 2B shows a structure in which magnetic material 55a is provided directly on the surface of conductor 54 so as to cover a portion of conductor 54 other than the upper surface thereof. FIG. 2C shows a structure in which magnetic material 55b is provided so as to cover a portion of conductor 54 other than the upper surface thereof, through the medium of a non-magnetic insulator 56a. FIG. 2D shows a structure in which magnetic materials 55 and 55a are provided directly on surfaces of conductor 54 so as to enclose the periphery of conductor 54. FIG. 2E shows a structure in

which magnetic materials 55 and 55c are provided so as to enclose the periphery of conductor 54 through the medium of a non-magnetic insulator 56b. FIG. 2F shows a structure in. which a magnetic material 55d having a width identical to that of conductor 54 is provided directly on conductor 54. FIG. 2G shows a structure in which magnetic material 55d is provided on conductor 54 through the medium of a non-magnetic insulator 56c. FIG. 2H shows a structure in which magnetic materials 55d and 55e are provided directly on surfaces of conductor 54 so as to be present on both sides thereof. FIG. 2I shows a structure in which magnetic materials 55d and 55e are provided so as to be present on both sides of conductor 54 through the medium of non-magnetic insulators 56c and 56d. The magnetic materials may be provided directly on surfaces of the conductor, or may be provided through the medium of non-magnetic insulators; any number of variations thereof are possible in addition to those shown in FIG. 2A.about.2I.

Detailed Description Text (13):
By constructing the magnetic sensor 50 as shown in FIGS. 2D, 2E, 2H, and 2I, it is possible to avoid the influence of the demagnetizing field H.sub.d of magnetic materials 55, 55a, 55c, 55d, and 55e, with respect to the high frequency magnetic field generated by conductor 54, and it is possible to restrict magnetic flux leakage, and to obtain a large SN ratio.

Detailed Description Text (16):
In the magnetic sensor 50 described above, by means of making the film thickness of the conductor 54 and the magnetic materials 55 thick, it is possible to reduce the impedance Z.sub.0, and to increase the mount of increase .DELTA.Z.sub.mag in the impedance, so that by means of appropriately setting these film thicknesses, it is possible to further increase the sensitivity and the SN ratio. In this case, when the film thickness of the magnetic materials 55 is made thick, as a result of the skin effect, the effective volume of the magnetic materials 55 is decreased. In order to avoid the skin effect, it is effective to employ a multi-layered structure, as is shown in FIG. 4, in which magnetic layers 57 and non-magnetic insulator layers 58 are alternately layered, as the cross sectional structure of the magnetic materials 55. In this case, it is effective to set the film thickness of the magnetic layers 57 so as to be thinner than the skin depth, and furthermore, it is effective to set the thickness of the non-magnetic insulator layers 58 to at least a thickness which is capable of maintaining electrical insulation between two magnetic layers 57. Here, the skin depth .delta. is the depth from the surface to which a high frequency electromagnetic wave is able to penetrate the magnetic material, and is expressed by the Formula (7) below, using the electrical resistivity .rho.m of the magnetic materials, the frequency f, the static relative magnetic permeability .mu..sub.r '(0), and the relative magnetic permeability .mu..sub.0 for a vacuum. ##EQU2##

Detailed Description Text (18):
First, with respect to the shape of magnetic sensor 50, the shapes shown in FIG. 1A and FIG. 2D were selected, and furthermore, the structure shown in FIG. 4 was selected as that of the magnetic materials, Cu having a thickness of 2 .mu.m was used as conductor 54, a NiFe alloy having a film thickness of 0.05 .mu.m was used as the magnetic layer 57, SiO.sub.2 having a thickness of 0.1 .mu.m was used as the non-magnetic insulator layer 58, and the total film thickness of the magnetic materials 55 and 55a was 1.5 .mu.m individually. Furthermore, the width of conductor 54 was set to 10 .mu.m, the length thereof was set to 100 .mu.m, the width of the magnetic materials 55 and 55a was set to 10 .mu.m, and the length thereof was set to 1000 .mu.m, and the number of magnetic materials 55 and 55a was set to 6 individually. The direction of the short side of the magnetic materials 55 and 55a was the easy axis direction of magnetic anisotropy. The ion-beam sputtering method and the photolithographic method were used for film formation and processing, respectively, and a uniaxial anisotropy magnetic field was given by means of film formation in a magnetic field.

Detailed Description Text (19):
With respect to the magnetic sensor 50 having the structure described above, an example is shown in FIG. 5 of the dependency of the peak-to-peak voltage change ratio .DELTA.V/V(0) between electrodes 53a and 53b, with respect to frequency (f), in the case in which a high frequency current is caused to flow between electrodes 53a and 53b by high frequency generator 51. The measurement was carried out at room temperatures. Here, V(0) represents the peak-to-peak voltage between electrodes 53a and 53b when an external magnetic field H.sub.EX is not applied, V(H) represents the peak-to-peak voltage between electrodes 53a and 53b when a magnetic field of 100 Oe, which is sufficiently larger than the anisotropic magnetic field of 5 Oe of the NiFe alloy, is applied as external magnetic field H.sub.EX, and .DELTA.V represents V (0)-V(H); the voltage change ratio .DELTA.V/V(0) corresponds to the SN ratio of magnetic sensor

50. Voltage change ratio .DELTA.V/V(0) has a large value within a range of 60.about.70% when the frequency of the high frequency current is within a range from a few hundred MHz to the vicinity of 1 GHz. The reason that the voltage change ratio .DELTA.V/V(0) becomes large in this frequency band is that this frequency band coincides with the magnetic resonance frequency, 600 MHz.about.1 GHz, of NiFe alloy. An example of the dependency of the peak-to-peak voltage V between electrodes 53a and 53b at 800 MHz with respect to an external magnetic field H.sub.EX is shown in FIG. 6. As can be seen from FIG. 6, the peak-to-peak voltage V between electrodes 53a and 53b decreases greatly at approximately anisotropic magnetic field of 50e of the NiFe alloy, and reaches an essentially constant value at 20 Oe.

Detailed Description Text (21):
Furthermore, as can be seen from FIG. 5, the voltage change ratio .DELTA.V/V(0) reaches a maximum value when the frequency of the high frequency current is set in the vicinity of the magnetic resonance frequency of the magnetic material 55. Accordingly, in order to obtain a high SN ratio and high sensitivity, the operation of the magnetic sensor 50 in the vicinity of this magnetic resonance frequency is effective.

Detailed Description Text (22):
Furthermore, with the magnetic sensor 50 having a structure in accordance with the First Embodiment, it is possible to cause a DC bias current to flow to conductor 54, to move the operational point on the V-H curve (see FIG. 6) by means of the bias magnetic field produced by the DC bias current at the position of the magnetic material 55, and thus to sense the polarity of the external magnetic field H.sub.EX, and it is possible to increase the sensitivity by moving the operational point to the point at which the slope of the V-H curve reaches a maximum value. At this time, a conductor 54 functions as a DC bias conductor in addition to its function as a conductor for supplying a high frequency current. Consequently, there is no need to install a separate DC bias conductor to supply a DC bias. Thus, the number of parts is reduced and the component structure is simplified. In addition to the functions of wave detection and demodulation, wave detector 52 must have the function of cutting the DC current during the process of wave detection in order to cancel the pre-installed DC bias current from the signal to be detected.

Detailed Description Text (24):
Examples of materials usable in the magnetic layer 57 include materials in which one or a plurality of elements selected from a group containing Fe, Co, Ni, Zr, Nb, Y, Hf, Ti, Mo, W, Ta, Si, B, and Re are added to Fe, Co, and Ni; examples of materials usable in the non-magnetic insulator layer 58 include, for example, SiO.sub.2, AlN, Al.sub.2 O.sub.3, BN, TiN, SiC, polyethylene naphthalate (PEN), polyethylene terephthalate (PET), polyimide, captone, photoresist, and the like, and examples of materials usable as conductor 54 include, for example, Cu, Al, Ag, Au, Pt, Sn, Cr, Zn, and In; similar effects may be obtained when any of these is employed.

Detailed Description Text (27):
FIG. 7A shows, in schematic form, the structure of a magnetic field sensing apparatus in accordance with the Second Embodiment of the present invention, and FIG. 7B is a cross sectional view taken along the line A--A' in FIG. 7A. In FIG. 7A, the magnetic sensing apparatus comprises a magnetic sensor 60, a high frequency generator 61, and a wave detector 62. The magnetic sensor 60 comprises a conductor 63, electrodes 64a.sub.1, 64a.sub.2, 64b.sub.1, and 64b.sub.2, and magnetic material 65. As shown in FIG. 7B, conductor 63 has a structure in which a conductor 63b is formed on a conductor 63a, and electrodes 64a.sub.2, 64b.sub.2, and electrodes 64a.sub.1, and 64b.sub.1 are connected to both ends of conductor 63a, or conductor 63b. As shown in FIG. 7B, magnetic material 65 comprises magnetic materials 65a and 65b, and magnetic materials 65a and 65b are formed directly on the surface of conductors 63a and 63b so as to enclose the periphery of conductors 63a and 63b. Magnetic sensor 60 possesses a gap g in a portion of the magnetic circuit thereof, and the gap g is formed by means of interposing conductor 63a between magnetic material 65a and magnetic material 65b.

Detailed Description Text (28):
FIGS. 8A.about.8E show, in schematic form, other structures of magnetic sensors 60.sub.1 .about.60.sub.5 which are employed in the magnetic field sensing apparatus in accordance with the Second Embodiment; these correspond to cross sectional views taken along the line A--A' in FIG. 7A. In FIG. 8A, magnetic sensor 60.sub.1 has a structure in which magnetic materials 65a and 65c are disposed directly on the surface of conductor 63a so as to enclose the periphery of conductor 63a. In magnetic sensor 60.sub.1, a gap g.sub.1 is provided

in a portion of the magnetic circuit thereof, and the gap g.sub.1 is formed by interposing conductor 63a between magnetic material 65a and magnetic material 65c.

Detailed Description Text (29):
In FIG. 8B, magnetic sensor 60.sub.2 has a structure in which conductor 63b is formed on conductor 63a, and magnetic materials 65a and 65d are disposed on the surfaces of conductors 63a and 63b through the medium of non-magnetic insulators 66a and 66b so as to enclose the periphery of these conductors 63a and 63b. Magnetic sensor 60.sub.2 possesses a gap g.sub.2 in a portion of the magnetic circuit thereof, and the gap g.sub.2 is formed by interposing conductor 63a and non-magnetic insulators 66a and 66b between magnetic material 65a and magnetic material 65d.

Detailed Description Text (30):
In FIG. 8C, magnetic sensor 60.sub.3 has a structure in which magnetic materials 65a and 65e are disposed on the surface of a conductor 63a through the medium of non-magnetic insulators 66a and 66c so as to enclose the periphery of conductor 63a. Magnetic sensor 60.sub.3 is provided with a gap g.sub.3 in a portion of the magnetic circuit thereof, and gap g.sub.3 is formed by interposing conductor 63a and non-magnetic insulators 66a and 66c between magnetic material 65a and magnetic material 65e.

Detailed Description Text (31):
In FIG. 8D, magnetic sensor 60.sub.4 has a structure in which magnetic materials 65a and 65f are disposed on the surface of conductor 63c through the medium of non-magnetic insulators 66b and 66d so as to enclose the periphery of conductor 63c. Magnetic sensor 60.sub.4 is provided with a gap g.sub.4 in a portion of the magnetic circuit thereof, and gap g.sub.4 is formed by interposing non-magnetic insulators 66b and 66d between magnetic material 65a and magnetic material 65f.

Detailed Description Text (32):
In FIG. BE, magnetic sensor 60.sub.5 has a structure in which magnetic materials 65a and 65g are disposed directly on the surface of conductor 63c so as to enclose the periphery of conductor 63c, and a gap g.sub.5 is provided in a portion of the magnetic circuit thereof by means of interposing non-magnetic insulator 66e between magnetic material 65a and magnetic material 65g.

Detailed Description Text (33):
Next, the operation of the magnetic field sensing apparatus in accordance with the Second Embodiment will be explained with reference to FIG. 7A and FIG. 9. First, in the recording process, a current corresponding to data which are to be recorded is passed through conductor 63a or 63b, and magnetic materials 65a and 65b are magnetized, and thereby, the magnetic recording medium 67 (see FIG. 9) is magnetized by means of the leakage magnetic field from gap g.sub.5, and the signal is recorded.

Detailed Description Text (34):
In the reproducing process, the changes in the external magnetic field H.sub.EX are converted to changes in impedance in conductor 63, based on changes in the relative magnetic permeability of magnetic materials 65a and 65b, and these changes in impedance are converted into changes in voltage amplitude by the four-terminal method, and reproduction is conducted. That is to say, the high frequency current having a frequency f which is generated by the high frequency generator 61 is applied between electrodes 64a.sub.1 and 64b.sub.1, and thereby, when a high frequency current having a frequency f is supplied to conductors 63a and 63b, the high frequency magnetic field generated based on this high frequency current is reflected and absorbed by magnetic materials 65a and 65b, so that the impedance Z(f) of magnetic sensor 60 at a frequency f is expressed by the Formula (2) shown above.

Detailed Description Text (36):
As shown in FIG. 9, external magnetic field H.sub.EX flows into magnetic materials 65a and magnetic material 65b, which are separated by gap g; however, the difference therebetween flows in a path which crosses or encloses the periphery of conductors 63a and 63b, and this magnetizes magnetic materials 65a and 65b based on the direction of the medium magnetization J.

Detailed Description Text (37):
In Formula (3), the value of the relative magnetic permeability .mu..sub.r (f) changes in

accordance with the magnetization state of magnetic materials 65a and 65b, so that the recorded signal, or the medium magnetization J, or the external magnetic field H.sub.EX becomes a change in the impedance Z(f) of conductor 63a and 63b, and accordingly, becomes a change in the peak-to-peak voltage between electrodes 64a.sub.2 and 64b.sub.2, and is reproduced. That is to say, the reproduced signal appears between electrodes 64a.sub.2 and 64b.sub.2 in the form of an AM modulation using the high frequency signal from high frequency generator 61 as a carrier. Accordingly, the reproduced signal is extracted by means of the detection of this signal in wave detector 62.

Detailed Description Text (38):
Furthermore, in order to sense the polarity of the external magnetic field H.sub.EX, a DC bias current is supplied to conductor 63a or conductor 63b, and the DC bias magnetic field generated based on this DC bias current is used. At this time, conductor 63a or 63b functions as a DC bias conductor in addition to its function as a conductor for supplying a high frequency current. Consequently, there is no need to install a separate DC bias conductor to supply a DC bias. Thus, the number of parts is reduced and the component structure is simplified. In addition to the functions of wave detection and demodulation, wave detector 62 must have the function of cutting the DC current during the process of wave detection in order to cancel the pre-installed DC bias current from the signal to be detected.

Detailed Description Text (41):
The amount of increase .DELTA.Z.sub.mag (f) in the impedance is proportional to the volume or the thickness of the magnetic material 65. In FIG. 9, the spatial resolution (linear recording density) of magnetic sensor 60 depends solely on the length of the gap g, and does not depend on the thickness of the magnetic materials 65a and 65b, so that it is possible to set the thickness of the magnetic materials 65a and 65b to a freely selected value so that the amount of change .DELTA.Z.sub.mag (f) in the impedance becomes sufficiently large. Furthermore, the impedance Z.sub.0 (f) is in essentially inverse proportion to the cross sectional area of the conductor 63. When the structure of the magnetic sensor is that shown in FIG. 7B, FIG. 8B, FIG. 8D, or FIG. 8E, then it is possible to freely set the thickness of conductors 63a, 63b, or 63c while keeping the length of the gap g, g.sub.2, g.sub.4, or g.sub.5 short, so that it is possible to reduce the value of the impedance Z.sub.0 (f) without reducing the spatial resolution (linear recording density).

Detailed Description Text (43):
Furthermore, in the Second Embodiment, the external magnetic field H.sub.EX and the magnetic materials 65a.about.65g form a closed magnetic path, so that since there is little magnetic flux leakage, even higher sensitivity is possible. Additionally, when the structure of the magnetic sensor is one of those shown in FIG. 7B, FIG. 8A, FIG. 8B, or FIG. 8C, conductors 63a and 63b are exposed in the direction of magnetic recording medium 67 (see FIG. 9), and conductors 63a and 63b are in proximity to magnetic recording medium 67, and thereby, even higher sensitivity becomes possible.

Detailed Description Text (47):
Hereinbelow, a concrete example will be explained. The shapes shown in FIGS. 7A and 7B were selected for the magnetic sensor 60, and the multi-layered structure shown in FIG. 10 was adopted for the magnetic material 65. NiFe alloy was employed in the magnetic layer 68, and the thickness thereof was set to 50 nm, which is sufficiently thinner than the skin depth. SiO.sub.2 was employed in the non-magnetic insulator layers 69, and the thickness thereof was set to 50 nm, which is sufficient to guarantee electrical insulation between magnetic layers 68 and 68. The thicknesses of the magnetic materials 65a and 65b were set to 3 .mu.m, and in order to avoid the influence of demagnetizing fields, the width of magnetic materials 65a and 65b was set to 5 .mu.m, and the length thereof was set to 200 .mu.m. A uniaxial anisotropy magnetic field of 3.about.5 Oe was given to the magnetic materials 65a and 65b so that the direction of the width thereof was the easy axis. Cu was employed in the conductors 63a and 63b, and the width of the conductor 63a was set to 8 .mu.m, the thickness thereof was set to 0.3 .mu.m, and the length thereof was set to 10 .mu.m, while the width of conductor 63b was set to 5 .mu.m, the thickness thereof was set to 0.7 .mu.m, and the length thereof was set to 10 .mu.m, and the length of the gap g was set to 0.3 .mu.m. The ion-beam sputtering method and the photolithographic method were used for film formation and processing, respectively, and a uniaxial anisotropy magnetic field was given by means of film formation in a magnetic field. The measurements were all carried out at room temperatures.

Detailed Description Text (48):

In FIG. 12, an example of the frequency characteristics of the voltage change ratio .DELTA.V/V (0) is shown. The voltage change ratio .DELTA.V/V(0) has a large value within a range of 60.about.70% when the frequency of the high frequency current is within a range of from a few hundred MHz to the vicinity of 1 GHz. The reason that the value of the voltage change ratio .DELTA.V/V(0) increases in this frequency band is that this frequency band coincides with the magnetic resonance frequency of the NiFe alloy which is employed in the magnetic material 65, which is 600.about.1000 MHz. An example of the dependence of the peak-to-peak voltage V between electrodes 64a.sub.2 and 64b.sub.2, with respect to the external magnetic field H.sub.EX, at 800 MHz is shown in FIG. 13. As can be seen in FIG. 13, the peak-to-peak voltage V decreases greatly in the vicinity of 3.about.5 Oe, which is the uniaxial anisotropy magnetic field of NiFe, and acquires an essentially constant value at a level of 10 Oe. Hysteresis was not observed in FIG. 13, and accordingly, it was confirmed that the signal sensing accuracy was high.

Detailed Description Text (49):
As explained above, in order to obtain a high SN ratio and high sensitivity, it is effective to set the frequency of the high frequency current from high frequency generator 61 to the vicinity of the magnetic resonance frequency of magnetic material 65. In the Second Embodiment, the reproduced signal is reproduced in the form of an AM modulation using the signal from the high frequency generator 61 as a carrier. In this case, in order to stably sense the reproduced signal, it is necessary that magnetic sensor 60 possess broad-band characteristics of 2 or more times the frequency of the reproduced signal, centering on the carrier frequency. As can be seen from FIG. 12, the voltage change ratio .DELTA.V/V(0) of the magnetic sensor 60 of the magnetic field sensing apparatus in accordance with the Second Embodiment has, for example, in a band larger than 60%, an extremely broad band on the level of 500 MHz within the range of 500 MHz.about.1 GHz, so that it is possible to stably reproduce a high frequency signal of approximately 250 MHz.

Detailed Description Text (51):
Examples of materials usable as magnetic materials 65a.about.65g and magnetic layers 68 include, for example, materials in which one or a plurality of elements selected from a group containing Fe, Co, Ni, Zr, Nb, Y, Hf, Ti, Mo, W, Ta, Si, B, and Re are added to Fe, Co, and Ni; and furthermore, examples of materials which may be used as the non-magnetic insulators 66a.about.66e and non-magnetic insulating layer 69 include, for example, SiO.sub.2, AlN, Al.sub.2 O.sub.3, BN, TiN, SiC, polyethylene naphthalate (PEN), polyethylene terephthalate (PET), polyimide, captone, photoresist, and the like, and materials which may be used as conductors 63a.about.63c include, for example, Cu, Al, Ag, Au, Pt, Sn, Cr, Zn, In, and the like; similar effects may be obtained when any of these is employed.

Detailed Description Text (55):
Next, a Third Embodiment of the present invention will be explained. FIG. 15 is a block diagram showing, in schematic form, the structure of a magnetic field sensing apparatus in accordance with the Third Embodiment of the present invention. In FIG. 15 the magnetic field sensing apparatus comprises: a magnetic sensor 70, a high frequency generator 71, a DC bias power supply 72, and a wave detector 73. FIG. 16A shows a front view of the magnetic sensor 70, and FIG. 16B is a cross sectional view taken along the line A--A' in FIG. 16A. In FIGS. 16A and 16B, the magnetic sensor comprises a coil 74, a magnetic core 75, a non-magnetic insulator 76, coil electrodes 77a and 77b, a conductor 78, and conductor electrodes 79a and 79b.

Detailed Description Text (56):
In the magnetic sensor 70 shown in FIGS. 16A and 16B, the coil 74 is wound in a spiral shape from the center thereof in an outward direction. Magnetic core 75 comprises magnetic materials 75a and 75b, which comprise single sheet magnetic materials. Magnetic materials 75a and 75b grip a portion of the lower side of coil 74, and are fastened by means of magnetic core coupler 75c. A gap g possessing a very small space is formed at the lower end between magnetic materials 75a and 75b. Non-magnetic insulator 76 fills the space between magnetic materials 75a and 75b in order to continuously support coil 74. Coil electrodes 77a and 77b are electrically connected to the two ends, the center and peripheral end, of coil 74. Between magnetic material 75a and magnetic material 75b, a sensing end 78a of the horizontal lower edge portion of a V-shaped conductor 78 passes through the non-magnetic insulator 76 in the vicinity of gap g. Conductor electrodes 79a and 79b are unitarily connected to the upper edges of wing-shaped portions 78b and 78c, which are widenings of the upper left and right ends of conductor 78.

Detailed Description Text (57):

FIGS. 17A.about.17H and 18A.about.18G show, in schematic form, other structures of the magnetic sensor 70; these correspond, respectively, to FIG. 16B. Insofar as the energy of the high frequency electromagnetic wave resulting from the high frequency current passed through conductor 78 can be applied to the magnetic core 75, the sensing end 78a may be disposed at a freely selected position either within the magnetic core 75, as shown in FIG. 17B, FIG. 17D, FIG. 17G, FIG. 18C, and FIG. 18F, or in the vicinity of the magnetic core 75, as shown in FIG. 17A, FIG. 17C, FIG. 17E, FIG. 17F, FIG. 17H, FIG. 18A, FIG. 18B, FIG. 18D, FIG. 1BE, and FIG. 18G; many variations are possible in addition to those shown in FIGS. 17A.about.17H and 18A.about.18G. Similar effects can be obtained even if a plurality of conductor electrodes 79a and 79b are provided, or if the sensing end 78a is disposed directly on magnetic core 75.

Detailed Description Text (59):
In the reproducing process, the high frequency current from the high frequency generator 71 (see FIG. 15) is applied to the conductor 78, and based on changes in the impedance of conductor 78 resulting from the magnetization state of the magnetic core 75, reproduction is carried out.

Detailed Description Text (60):
Hereinbelow, the operational principle of the reproducing process will be explained. When a high frequency current having a frequency f is supplied to the conductor 78 by means of applying, between conductor electrodes 79a and 79b, a high frequency current having a frequency f which is generated by the high frequency generator 71, the high frequency magnetic field generated based on this high frequency current is reflected and absorbed by magnetic materials 65a and 65b, so that the impedance Z(f) of magnetic sensor 70 at a frequency f is expressed by the Formula (2) shown above.

Detailed Description Text (62):
When the magnetic core 78 becomes magnetized by external magnetic field H.sub.EX, the value of the relative magnetic permeability .mu..sub.r (f) decreases, and in the magnetization saturation state, the relative magnetic permeability .mu..sub.r (f) has a value of 0. At this time, the dependency of the peak-to-peak voltage V produced between conductor electrodes 79a and 79b on external magnetic field H.sub.EX is shown conceptually in FIG. 19.

Detailed Description Text (63):
If the amplitude of the high frequency current is made essentially constant, the SN ratio of the magnetic sensor 70 is expressed by the Formula (5) shown above. In this Third Embodiment, in Formula (5), V(0) represents the peak-to-peak voltage between conductor electrodes 79a and 79b in the case in which an external magnetic field H.sub.EX is not applied, and V(H) represents the peak-to-peak voltage between conductor electrodes 79a and 79b when the magnetic core 75 is saturated. Since the value of impedance Z.sub.0 (f) is small, and the amount of increase .DELTA.zmag(f) in the impedance becomes large in high frequency regions, then from Formula (5), the voltage change ratio .DELTA.V/V(0) acquires an extremely high value, and the SN ratio has an extremely high value. Furthermore, the magnetic core 75 of magnetic sensor 70 has characteristics such that it is saturated by a weak magnetic field, and has small hysteresis, so that the sensitivity and the signal sensing accuracy are improved.

Detailed Description Text (64):
Furthermore, in order to sense the polarity of the external magnetic field H.sub.EX, a DC bias magnetic field H.sub.bias is generated by supplying a DC bias current to conductor 78 or coil 74, and the operational point along the V-H curve as shown in FIG. 19 is moved to P.sub.0. In this case, in the magnetic sensor 70 which is employed in the magnetic field sensing apparatus of the Third Embodiment, conductor 78 or coil 74 is used in addition to the DC bias conductor 9 of the conventional MR head shown in FIG. 25, so that the component structure is simplified. Furthermore, the operational point P.sub.0 is set at the point on the V-H curve having the maximum slope, and thereby, it is possible to further increase the sensing sensitivity. In addition to the functions of wave detection and demodulation, wave detector 73 must have the function of cutting the DC current during the process of wave detection in order to cancel the pre-installed DC bias current from the signal to be detected.

Detailed Description Text (66):
High frequency generator 71 supplies a high frequency current to conductor 78 by means of the application of a high frequency current of, for example, 800 MHz, such as that shown in FIG. 20A, between conductor electro es 79a and 79b. Furthermore, the DC bias power supply 72 supplies a DC bias current to conductor 78 or coil 74 by means of applying a DC bias current

such as that shown in FIG. 20B between conductor electrodes 79a and 79b, or coil electrodes 77a and 77b.

Detailed Description Text (67):
By means of this DC bias current, a DC bias magnetic field H.sub.bias is generated, and operational point P is moved to operational point P.sub.0 which is shown in FIG. 19. Here, a magnetic field of, for example, 30 MHz, which is shown in FIG. 20C, is applied as the signal magnetic field, and by means of this, the voltage V between the conductor electrodes 79a and 79b alternates between the voltage V (operational point P.sub.1) and the voltage V (operational point P.sub.2), which are shown in FIG. 19.

Detailed Description Text (68):
A voltage in which an 800 MHz signal is amplitude modulated with a 30 MHz signal is generated between conductor electrode 79a and 79b, as shown in FIG. 20D after cutting a DC current. This is detected by wave detector 73, and thereby, it is possible to reproduce the 30 MHz signal as the output voltage shown in FIG. 20E.

Detailed Description Text (72):
Furthermore, the total film thickness of the magnetic core 75 was set to 3 .mu.m, the width of the lower end portion of the magnetic core 75 was set to 10 .mu.m, and the length of gap g was set to 0.3 .mu.m, while Cu having a thickness of 1 .mu.m was used in conductor 78, and the width of conductor 78 was set to 10 .mu.m. The ion-beam sputtering method and the photolithographic method were used for film formation and processing, respectively, and a uniaxial anisotropy magnetic field was given by means of film formation in a magnetic field. The measurements were all carried out at room temperatures.

Detailed Description Text (73):
In FIG. 22, an example of the dependency on the frequency f of the voltage change ratio .DELTA.V/V(0) of the magnetic field sensing apparatus in accordance with the Third Embodiment is shown. The voltage change ratio .DELTA.V/V(0) has a large value within a range of 60.about.70% within a frequency range of from a few hundred MHz to the vicinity of 1 GHz. The reason that the voltage change ratio .DELTA.V/V(0) becomes large in this frequency band is that this frequency band coincides with the magnetic resonance frequency, 600 MHz.about.1 GHz, of the NiFe alloy which is employed in the magnetic core 75.

Detailed Description Text (74):
Here, an example of the dependence, on the external magnetic field H.sub.EX, of the peak-to-peak voltage V at a frequency of 800 MHz is shown in FIG. 23. The peak-to-peak voltage V decreases greatly at approximately 5 Oe, which is the anisotropic magnetic field of NiFe, and attains an essentially constant value at approximately 20 Oe.

Detailed Description Text (76):
As shown in FIG. 22, the voltage change ratio .DELTA.V/V(0) attains a maximum value when the frequency of the high frequency current is in the vicinity of the magnetic resonance frequency of the magnetic material used in magnetic core 75. Accordingly, in order to obtain a high SN ratio and high sensitivity, it is effective to operate the magnetic field sensing apparatus in accordance with the Third Embodiment in the vicinity of the magnetic resonance frequency of the magnetic material which is used in the magnetic core 75.

Detailed Description Text (78):
Furthermore, materials usable in magnetic core 75 and magnetic layers 75e include materials in which one or a plurality of elements selected from a group containing Fe, Co, Ni, Zr, Nb, Y, Hf, Ti, Mo, W, Ta, Si, B, and Re are added to Fe, Co, and Ni; examples of materials which may be used in nonmagnetic insulators 76 and non-magnetic insulator layers 75f include, for example, SiO.sub.2, AlN, Al203, BN, TiN, SiC, polyethylene naphthalate (PEN), polyethylene terephthalate (PET), polyimide, captone, photoresist, and the like; furthermore, materials which may be used in conductor 78 and coil 74 include, for example, Cu, A, Ag, Au, Pt, Sn, Cr, Zn, and In; similar effects may be obtained when any of the above are employed.

Other Reference Publication (1):
Masakatsu Senda et al., "High frequency measurement technique for patterned soft magnetic film permeability with magnetic film/conductor/magnetic film inductance line," Review of Scientific Instruments, No. 4 (Apr., 1993), pp. 1034-1037.

CLAIMS:

1. A magnetic field sensing method, comprising the steps of:

providing a magnetic sensor comprising a conductor and at least one magnetic material disposed such that the magnetic material encloses a periphery of said conductor, wherein a magnetic circuit formed by said magnetic material contains a gap, said sensor arranged such that said gap faces an external magnetic field to be sensed, said magnetic material being formed with a multi-layered structure in which magnetic layers and non-magnetic insulator layers are alternatively layered, a thickness of each magnetic layer being thinner than a skin depth, and each non-magnetic insulator layer having a thickness capable of at least maintaining electrical insulation between the magnetic layers;

supplying, through two lead wires, a high frequency current to said conductor, the frequency of the high frequency current being approximately equal to a magnetic resonance frequency of the magnetic material; and

sensing, through two other lead wires, said external magnetic field based on voltage changes obtained through the two other lead wires by converting changes in impedance of said conductor due to said magnetic material into voltage changes by means of a four-terminal method.

2. A magnetic field sensing method in accordance with claim 1, characterized in that said magnetic material is provided on any surface of said conductor through the medium of a non-magnetic insulator.

3. A magnetic field sensing method in accordance with claim 1, characterized in that a DC bias current is supplied to said conductor.

4. A magnetic field sensing method in accordance with claim 1, characterized in that said magnetic material is formed in a rectangular plate shape, a long side thereof is positioned so as to be parallel with the direction of said external magnetic field, and uniaxial magnetic anisotropy is possessed such that the short side direction thereof is an easy axis.

5. A magnetic field sensing method in accordance with claim 1, wherein the frequency of the high frequency current is approximately within the range of -200 MHz and +200 MHz relative to the magnetic resonance frequency of the magnetic material.

6. A magnetic field sensing apparatus, comprising:

a magnetic sensor comprising a conductor and at least one magnetic material provided so as to enclose a peripheW of said conductor, wherein a gap is provided in a portion of a magnetic circuit formed by said magnetic material, said gap facing an external magnetic field which is to be sensed, and wherein said conductor comprises two ends, said magnetic material being formed with a multi-layered structure in which magnetic layers and non-magnetic insulator layers are alternatively layered, a thickness of each magnetic layer being thinner than a skin depth, and each non-magnetic insulator layer having a thickness capable of at least maintaining electrical insulation between the magnetic layers;

a high frequency generator for supplying, through two lead wires, a high frequency current to said conductor, the frequency of the high frequency current being approximately equal to a magnetic resonance frequency of the magnetic material supplied a to the conductor; and

a detector for detecting, through two other lead wires, changes in voltage amplitude obtained at both ends of said conductor by converting changes in impedance of said conductor due to the magnetic material, in accordance with the external magnetic field, into voltage changes by means of a four-terminal method.

7. A magnetic field sensing apparatus in accordance with claim 6, wherein said magnetic material covers the entirety of said conductor.

8. A magnetic field sensing apparatus in accordance with claim 6, wherein said magnetic material covers approximately the entirety of said conductor.

9. A magnetic field sensing apparatus in accordance with claim 6, wherein the frequency of the

high frequency current is approximately within the range of -200 MHz and +200 MHz relative to the magnetic resonance frequency of the magnetic material.

10. A magnetic field sensing apparatus in accordance with claim 6, wherein said DC bias current is set to a value so to maximize the slope of the voltage amplitude change between the ends of said conductor with respect to the change in the external magnetic field.

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1. Document ID: US 20030155667 A1

L17: Entry 1 of 5 File: PGPB Aug 21, 2003

PGPUB-DOCUMENT-NUMBER: 20030155667
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20030155667 A1

TITLE: Method for making or adding structures to an article

PUBLICATION-DATE: August 21, 2003

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY
Devoe, Robert J	Oakdale	MN	US
Duerr, Brook F	Lake Elmo	MN	US
Fleming, Patrick R	Lake Elmo	MN	US
Kalweit, Harvey W	Burnsville	MN	US

US-CL-CURRENT: 264/1.27; 264/1.31, 264/16, 264/482, 264/494

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KWIC | Draw Desc | Image

2. Document ID: US 20030002132 A1

L17: Entry 2 of 5 File: PGPB Jan 2, 2003

PGPUB-DOCUMENT-NUMBER: 20030002132
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20030002132 A1

TITLE: Photochromic electrophoretic ink display

PUBLICATION-DATE: January 2, 2003

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY
Foucher, Daniel A.	Rochester	NY	US
Patel, Raj D.	Oakville,		CA
Chopra, Naveen	Oakville		CA
Kazmaier, Peter M.	Mississauga		CA
Wojtyk, James	Ottawa		CA
Buncel, Erwin	Kingston		CA

US-CL-CURRENT: 359/296

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KWIC | Draw Desc | Image

3. Document ID: US 7229927 B1

L17: Entry 3 of 5 File: USPT Jun 12, 2007

US-PAT-NO: 7229927
DOCUMENT-IDENTIFIER: US 7229927 B1

TITLE: Semiconductor processing silica soot abrasive slurry method for integrated circuit microelectronics

DATE-ISSUED: June 12, 2007

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Darcangelo; Charles M.	Corning	NY		US
Sabia; Robert	Corning	NY		US
Sell; Robert D.	Horseheads	NY		US
Stevens; Harrie J.	Corning	NY		US
Ukrainczyk; Ljerka	Painted Post	NY		US

US-CL-CURRENT: 438/693; 257/E21.23, 257/E21.304

Full | Title | Citation | Front | Review | Classification | Date | Reference | Claims | KWIC | Draw Desc | Image

4. Document ID: US 6517618 B2

L17: Entry 4 of 5 File: USPT Feb 11, 2003

US-PAT-NO: 6517618
DOCUMENT-IDENTIFIER: US 6517618 B2

TITLE: Photochromic electrophoretic ink display

DATE-ISSUED: February 11, 2003

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Foucher; Daniel A.	Rochester	NY		
Patel; Raj D.	Oakville			CA
Chopra; Naveen	Oakville			CA
Kazmaier; Peter M.	Mississauga			CA
Wojtyk; James	Ottawa			CA
Buncel; Erwin	Kingston			CA

US-CL-CURRENT: 106/31.16; 106/31.32, 106/31.49, 106/31.64, 106/31.78

Full | Title | Citation | Front | Review | Classification | Date | Reference | Claims | KWIC | Draw Desc | Image

5. Document ID: US 5729188 A

L17: Entry 5 of 5 File: USPT Mar 17, 1998

US-PAT-NO: 5729188
DOCUMENT-IDENTIFIER: US 5729188 A

TITLE: Homogeneous field magnet with at least one pole plate to be mechanically aligned

DATE-ISSUED: March 17, 1998

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Siebold; Horst	Erlangen			DE
Ries; Gunter	Erlangen			DE
Rockelein; Rudolf	Erlangen			DE

US-CL-CURRENT: 335/298; 324/319, 335/297

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw Desc | Image

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Term	Documents
T	5458168
TS	644950
TESLA	11531
TESLAS	773
3T	53071
3TS	1105
4T	78083
4TS	3572
5T	25320
5TS	358
6T	98281
(L16 AND ("T" OR TESLA OR "3T" OR "4T" OR "5T" OR "6T" OR "7T")).PGPB,USPT,USOC,EPAB,JPAB,DWPI,TDBD.	5

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☐ 1. Document ID: US 20070238969 A1

L28: Entry 1 of 7 File: PGPB Oct 11, 2007

PGPUB-DOCUMENT-NUMBER: 20070238969
PGPUB-FILING-TYPE:
DOCUMENT-IDENTIFIER: US 20070238969 A1

TITLE: Diffusion-based magnetic resonance methods for characterizing bone structure

PUBLICATION-DATE: October 11, 2007

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY
Song; Yi-Qiao	Ridgefield	CT	US
Sigmund; Eric E.	New York	NY	US
Cho; HyungJoon	Somerville	MA	US

US-CL-CURRENT: 600/410

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KWIC | Draw Desc | Image

☐ 2. Document ID: US 20060197529 A1

L28: Entry 2 of 7 File: PGPB Sep 7, 2006

PGPUB-DOCUMENT-NUMBER: 20060197529
PGPUB-FILING-TYPE:
DOCUMENT-IDENTIFIER: US 20060197529 A1

TITLE: MAGNETIC RESONANCE SPECTROMETER

PUBLICATION-DATE: September 7, 2006

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY
Geifman; Ilia	Glenview	IL	US
Golovina; Irina Sergeevna	Kiev		UA

US-CL-CURRENT: 324/316; 324/318

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KWIC | Draw Desc | Image

☑ 3. Document ID: US 20020135367 A1

L28: Entry 3 of 7 File: PGPB Sep 26, 2002

PGPUB-DOCUMENT-NUMBER: 20020135367
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20020135367 A1

TITLE: Method and apparatus for shortening T1 or T2, or lengthening the ADC of a substance by the use of electric current

PUBLICATION-DATE: September 26, 2002

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY
Ueno, Shoogo	Tokyo		JP
Iriguchi, Norio	J-Kanagawa		JP
Sekino, Masaki	Tokyo		JP
Yamaguchi, Kikuo	Saitama		JP

US-CL-CURRENT: 324/309; 324/300, 324/318

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KMC | Draw Desc | Image

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☐ 4. Document ID: US 7268549 B2

L28: Entry 4 of 7 File: USPT Sep 11, 2007

US-PAT-NO: 7268549
DOCUMENT-IDENTIFIER: US 7268549 B2

TITLE: Magnetic resonance spectrometer

DATE-ISSUED: September 11, 2007

PRIOR-PUBLICATION:

DOC-ID	DATE
US 20060197529 A1	September 7, 2006

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Geifman; Ilia Natanovich	Glenview	IL		US
Golovina; Irina Sergeevna	Kiev			UA

US-CL-CURRENT: 324/316; 324/318

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KMC | Draw Desc | Image

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☑ 5. Document ID: US 6624632 B2

L28: Entry 5 of 7 File: USPT Sep 23, 2003

US-PAT-NO: 6624632
DOCUMENT-IDENTIFIER: US 6624632 B2

TITLE: Method and apparatus for shortening T1 or T2, or lengthening the ADC of a substance by the use of electric current

DATE-ISSUED: September 23, 2003

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Iriguchi; Norio	J-Kanagawa			JP
Sekino; Masaki	Tokyo			JP
Ueno; Shoogo	Tokyo			JP
Yamaguchi; Kikuo	Saitama			JP

US-CL-CURRENT: 324/309; 324/300

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw Desc | Image

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☐ 6. Document ID: US 6194900 B1

L28: Entry 6 of 7 File: USPT Feb 27, 2001

US-PAT-NO: 6194900
DOCUMENT-IDENTIFIER: US 6194900 B1

TITLE: Integrated miniaturized device for processing and NMR detection of liquid phase samples

DATE-ISSUED: February 27, 2001

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Freeman; Dominique M.	Pescadero	CA		
Swedberg; Sally A.	Palo Alto	CA		

US-CL-CURRENT: 324/321; 324/318

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw Desc | Image

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☐ 7. Document ID: US 2911587 A

L28: Entry 7 of 7 File: USOC Nov 3, 1959

US-PAT-NO: 2911587
DOCUMENT-IDENTIFIER: US 2911587 A

TITLE: Proton resonance monitor

DATE-ISSUED: November 3, 1959

INVENTOR-NAME: BAYLY JOHN G

US-CL-CURRENT: 324/321

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw Desc | Image

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Term	Documents
(27 AND 24).PGPB,USPT,USOC,EPAB,JPAB,DWPI,TDBD.	7
(L27 AND L24).PGPB,USPT,USOC,EPAB,JPAB,DWPI,TDBD.	7

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L28: Entry 5 of 7 File: USPT Sep 23, 2003

DOCUMENT-IDENTIFIER: US 6624632 B2
TITLE: Method and apparatus for shortening T1 or T2, or lengthening the ADC of a substance by the use of electric current

Abstract Text (1):
In a method and apparatus for obtaining magnetic resonance data from water-containing substance, nuclear spins are excited in the substance in the presence of a homogenous static magnetic field, while an electrical current is flowing in the subject. The electrical current flowing in the subject shortens the spin-spin relaxation time and the spin-lattice relaxation time, and lengthens the apparent diffusion coefficient of the substance.

Brief Summary Text (3):
The present invention relates to techniques in the field of magnetic resonance imaging (MRI) and magnetic resonance spectroscopy (MRS). The present invention also relates to techniques for measuring the spatial distribution of the electrical properties of substances such as electrolyte solutions, the tissues of a living body and human tissues by the use of MRI or MRS. The present invention relates also to techniques for measuring the spatial distributions of the currents within these substances.

Brief Summary Text (5):
Magnetic resonance signals are high-frequency signals, typically on the order of microvolts, which have weak frequencies produced by the precession of atomic nuclei (spins) in a static magnetic field. The frequency of the precession is determined by the magnetic field strength and the type of nucleus in question. The spins are aligned by the homogenous static magnetic field, and are excited by the application of an RF field, with the resulting magnetic resonance signals being detected as a voltage with a resonant coil (antenna).

Brief Summary Text (6):
An MR image is abbreviated MRI, and the method for acquiring it is called MR imaging which is abbreviated MRI. Further, MR spectral curve is referred to as an MR spectrum which is abbreviated MRS, and the acquisition of it or the method for acquiring it is called MR spectroscopy, which is abbreviated MRS.

Brief Summary Text (7):
Since R. Damadian found in the early 1970s that the spin-lattice relaxation time T1 and the spin-spin relaxation time T2 vary with tissues significantly, and tumorous tissues have extremely longer relaxation times than normal tissues (R. Damadian, "Tissue detection by nuclear magnetic resonance." Science vol. 171: pp. 1151-1153, published in 1971), the relaxation times T1 and T2 have been recognized as very important parameters in developing and designing magnetic resonance imaging systems and obtaining and evaluating magnetic resonance images and spectra.

Brief Summary Text (8):
The relaxation time T1 is the time constant required for the spins excited in a static magnetic field to return to their initial state in which they can be excited again. Accordingly, if T1 of the tissues of a living body or the like (examination subject) is particularly long, then a correspondingly longer time is needed for obtaining the magnetic resonance signals by repeating the excitation, returning the spins to the initial state, and for obtaining MRI or MRS by performing calculations such as two-dimensional Fourier transform or one-dimensional Fourier transform with a computer. In case of a clinical MRI apparatus, the patient, who is not allowed to move during the image pickup, is more burdened. Further, the number of patients who can be imaged over a given time is decreased. Accordingly, it is generally considered better for T1 to be shorter.

Brief Summary Text (11):
More specifically, it is known that the ions of a magnetic material such as a transition metal and lanthanide ions have unpaired electronic spins which have magnetic moments several hundreds of times as large as protons, and thus have strong relaxation effects. As an application example of such substances, the injection of a gadolinium compound, which is a paramagnetic material, into the circulatory system of an examination subject is widely practiced in the field of clinical MRI. If a gadolinium compound is introduced into the tissue of a living body, it has a relatively larger shortening effect on T1, which is originally long, than on T2 which is originally short.

Brief Summary Text (12):
In other words, if the gadolinium compound is introduced into a vein, then it is absorbed into the blood or the brain tissue or the like if the cerebral blood vessel barrier has been destroyed by a cerebral infarction or the like. This selectively shortens the T1 of the tissue, so that the site of disease or the like can be selectively imaged or depicted in a T1-weighted image (that is, an image which is generated, by obtaining successive sets of magnetic resonance signals by repeating the excitation after each return of the spins to the initial state.) In such an image a substance which has a short T1 and is therefore apt to return to the initial state in which, even if previously excited, it can be excited again, produces a higher amplitude signal and thus appears brighter in the image.

Brief Summary Text (14):
Further, in the middle 1960's, E. O. Stejskal and J. E. Tanner developed a diffusion measurement method by nuclear magnetic resonance that uses a motion probing gradient (MPG) pulses. [E. O. Stejskal and J. E. Tanner, "Spin diffusion measurements: spin-echoes in the presence of time-dependent field gradient." J. Chem. Phys. Vol. 42: pp. 288-292, published in 1965].

Brief Summary Text (16):
Further, D. Le Bihan, etc. introduced MRI techniques that incorporate MPG pulses into imaging sequences of MRI in mid-1980s. [D. Le Bihan, E. Breton, D. Lallemand, P. Granier, E. Cabanis and M. Laval-Jeantet, "MR imaging of intravoxel incoherent motions: application to diffusion and perfusion in neurological disorders." Radiology Vol. 161: pp. 401-407, published in 1986].

Brief Summary Text (17):
Since then, the diffusion-weighted MRI techniques have been widely used as a very important imaging methods because, for important lesions like acute cerebral infarctions which cannot be depicted, unless two or three days lapse after the beginning of the disease, by T1-weighted imaging or T2-weighted imaging. Using diffusion-weighted imaging, these important lesions are imaged 20 to 30 minutes after the development of the disease.

Brief Summary Text (18):
The diffusion of certain molecules in the same substance, such as water molecules diffusing in water, is called self-diffusion. Accordingly, the diffusion coefficient of a substance itself refers to the self-diffusion coefficient. Self-diffusion is originally isotropic. However, among the movements of spins in living bodies, etc., not only do movements due to diffusion occur, but also some movements due to blood flow occur. More precisely, therefore, the measured diffusion coefficient of the water molecules is called the apparent diffusion coefficient (ADC). In particular, if the gradient factor attenuation value (which is sometimes abbreviated b-factor) that is determined dependent on the magnitude, the length in time and the pulse interval of each of the MPG pulses) is very small, the detection of only the movement due to the diffusion of the spins is very difficult, because the movement of the spins due to the blood flow, etc. also is detected. However, MPG pulses of such a degree that are in practical use in ordinary diffusion-weighted imaging sequences in clinical MRI, etc. at present can make the ADC value almost equal to the diffusion coefficient by sufficiently increasing the b-factor. Concerning the b-factor, details are given in the above-mentioned literature of Le Bihan, etc.

Brief Summary Text (19):
Further, a method of making a measurement by magnetic resonance while flowing an electric current through an electrolyte solution, is disclosed in U.S. Pat. No. 5,757,185.

Brief Summary Text (21):

There is no discussion in the aforementioned patent that applying an electric current through an electrolyte solution has any effect on T1 or T2. Moreover, the technique according to the aforementioned patent for detecting the motion of the ions or molecules produced by an electric field and thus differs from known techniques for detecting the self-diffusion that develops isotropically.

Brief Summary Text (24):
Another object of the present invention is to provide a technique for markedly increasing the ADC of a water-containing substance, so that the diffusion-weighted sensitivity is enhanced, in the context of a diffusion-weighted MRI or diffusion-weighted MRS.

Brief Summary Text (25):
Still another object of the present invention is to provide a technique for measuring the spatial distribution of the electrical properties of a water-containing substance by the use of MRI or MRS.

Brief Summary Text (26):
Still another object of the present invention is to provide a technique for measuring the spatial distribution of the electric currents in the interior of a water-containing substance by the use of MRI or MRS.

Brief Summary Text (28):
The first object also is achieved in accordance with the present invention in a method for obtaining magnetic resonance images or spectra wherein a water-containing substance is placed in a static magnetic field, and, by a radio-frequency magnetic field, nuclear spins in the substance are excited to generate magnetic resonance signals, and wherein, by applying an electric current through said substance, the T1 or T2 of the substance is reduced.

Brief Summary Text (30):
The second object also is achieved in accordance with the present invention also lies in a method for obtaining a magnetic resonance image or spectrum wherein a water-containing substance is placed in a homogeneous static magnetic field, and, by a radio-frequency magnetic field, nuclear spins in the substance are excited to generate magnetic resonance signals, and wherein, by applying an electric current through the substance, the ADC of the substance is increased.

Brief Summary Text (31):
The third and fourth objects are achieved in accordance with the present invention in a method for obtaining a magnetic resonance image or spatial information representing an electrical property of a water-containing substance wherein a T1-weighted, T2-weighted or diffusion-weighted magnetic resonance image, or localized magnetic resonance spectra is/are obtained,while applying an electric current through the substance, and wherein these images or spectra are compared to images or localized spectra obtained without applying the electric current.

Brief Summary Text (33):
The first object also is achieved in accordance with the present invention in an apparatus for obtaining a magnetic resonance image of a water-containing substance having a basic field magnet which generates a homogeneous static magnetic field, an RF system which generates a radio-frequency field, a gradient system which generates gradient magnetic fields, and a computer which generates an image from the received magnetic resonance signals and an arrangement for applying an electric current through the substance while the nuclear spins are processing, to reduce T1 or T2 of the substance.

Brief Summary Text (34):
A further embodiment of the present invention is an apparatus for obtaining a magnetic resonance image of a water-containing substance having a basic field magnet which generates a homogeneous static magnetic field, an RF system which generates a radio-frequency magnetic field, a gradient system which generates gradient magnetic fields, and a computer which generates an image from the received magnetic resonance signals, and an arrangement for applying motion probing gradient (MPG) pulses through the substance, and an arrangement for applying an electric current through the substance, to increase the ADC of the substance as the magnetic resonance signals are being generated and received.

Brief Summary Text (35):
A further embodiment of the present invention is a method for obtaining spatial information, by magnetic resonance, representing the internal electric current evoked in a water-containing substance, wherein T1-weighted or T2-weighted or diffusion-weighted magnetic resonance images or localized magnetic resonance spectra while an internal current is caused to flow in the substance, and wherein images or localized spectra are obtained without an internal current flowing in the substance, which are compared to the images or the localized spectra obtained with the internal current.

Brief Summary Text (42):
Further, it is believed that, if an electric current is applied, the electrolytic ions move with the hydration shells in a manner taking many water molecules with them, as a result of which the movement of the water molecules is caused, and thus the ADC is remarkably increased. Here, the important feature pertaining to the increase of the ADC in the present invention is that the increase is developed isotropically. The mechanism therefor is believed to be in that the replacement, in a direction perpendicular to the movement, of the water molecules with the surrounding water molecules, which is caused by the movement of the hydration shells, occurs isotropically. Therefore, it is believed that the increase of the ADC in the present invention is also due to the fact that the diffusion coefficient substantially increases.

Brief Summary Text (43):
Further, T1-weighted or T2-weighted images or diffusion-weighted images can be obtained while applying an electric current through a water-containing substance, and a comparison is made between these images and corresponding control images obtained without applying an electric current. Such a comparison can be subtraction or division of attributes the images, or image calculations such as statistical inspection, etc. among many images. The tissues through which the electric current flow is higher exhibit a greater T1 shortening effect or T2 shortening effect or ADC increasing effect according to the present invention. Therefore, images in which the distribution of the electrical conductivity is represented can be obtained.

Brief Summary Text (44):
Further, according to the present invention, T1-weighted images can be obtained while applying an electric current through a water-containing substance, then T1 is shortened, as a result of which the intensity of the signals obtained is markedly high, and therefore the obtained images are bright. Alternatively, a T1-weighted image can be obtained with a "conventional" brightness but the scan can be completed in a shorter time as a whole in connection with MRI or MRS. Accordingly, in a clinical MRI apparatus, the stores the patients can be markedly reduced and patient throughput can be increased.

Brief Summary Text (48):
Thus, T1-weighted or T2-weighted or diffusion-weighted magnetic resonance images or local magnetic resonance spectra are obtained when an internal electric current exists and when no internal electric current exists, and, between the data obtained when the internal electric current exists and the data obtained when no internal electric current exists, a comparison is made by performing subtractions and divisions or, among many datasets, a comparison is made by performing statistical inspection, etc. This allows information pertaining the spatial distribution of the internal currents and/or magnetic resonance images which represent the spatial distribution of the internal currents to be obtained.

Detailed Description Text (3):
Referring to FIG. 1, a phantom sample of an electrolyte solution 5 is placed in the static magnetic field of a horizontal superconducting magnet 1 of an MRI apparatus. The phantom sample 5 is connected to a current source 6 through a lead wire 7. The MRI apparatus also has a gradient magnetic field coil assembly 2 and a radio-frequency coil 4. The gradient magnetic field coil assembly 2 is supplied with an electric current from an electrical power supply 3 for the gradient magnetic field coil or coils, and produces gradient magnetic fields in the homogeneous static magnetic field volume of the magnet 1.

Detailed Description Text (4):
The gradient magnetic field power supply 3 is operated by a command sent from an unillustrated man-machine interface. Power is supplied to the radio-frequency coil 4 in a transmit mode via a transmit/receive changeover switch 8 from a radio-frequency amplifier 10, causing spins to be excited in the phantom sample 5. Conversely, in a reception mode the magnetic resonance signals generated by the proton spins are detected as an induced electromotive force by the radio-

frequency coil 4 and are sent to a computer 11 through the transmit/receive changeover switch 8 and an amplifier stage 9 (for example a pre-amplifier and an intermediate amplifier). After known data processing such as Fourier transformation, etc., In the computer 11, data are supplied to a display 12 as MRI or MRS data. The radio-frequency amplifier 9 is also operated by the command sent from the man-machine interface.

Detailed Description Text (5):
According to the present invention, the electrical current applied from outside to a tested subject (in case of FIG. 1, the phantom sample 5) is an alternating current of 10 Hz or below, preferably 2 Hz or below, or a direct electric current. The lower the frequency, the larger the T1 shortening effect, the T2 shorting effect and the ADC increasing effect become, and the use of DC current is the most effective. In case of cellular tissues constituting a living body, AC currents are easier to conduct than DC currents, and a suitable frequency range thereof is 0.1 to 1.0 Hz.

Detailed Description Text (7):
On the other hand, in most cases the higher the current density is, the larger the T1 shortening effect and the ADC increasing effect will be. The practical current density range is 0.02 to 2.0 mA/cm.sup.2 and preferably is 0.05 to 1.0 mA/cm.sup.2 However, these current values should be set to lower values for safety if the invention is applied to a human body in the medical field, since the brain and the heart are organs which generate currents by themselves. Also in the fields of biology, veterinary medicine, botany, etc., the present invention exhibits marked effects as long as a water-containing substance is the subject, for shortening T1 or T2 or increasing ADC to perform MRI or MRS. When the present invention is employed for measuring the physical properties of water-containing substances other than the human body, allowable current values appropriate for the respective substances may of course be employed.

Detailed Description Text (8):
In the present invention, an electric current can be applied through an electrically conductive paste by the use, as electrodes, of non-magnetic metal foils, graphite plates or carbon powder-containing rubber plates. Where the tested subject is covered by an electrically conductive body, then radio-frequency eddy currents are caused to flow though the conductive body by the external radio-frequency field used for the excitation of spins, and thus the external RF field does not reach the interior of the tested subject. In an exemplary embodiment of the inventive method, an electrically conductive rubber band is placed around the wrist as one electrode, and another electrically conductive rubber band is placed around the upper arm as the other electrode, and an electric current is caused to flow between the wrist and the upper arm.

Detailed Description Text (9):
An external DC or low-frequency AC power source unit for this current, which has a magnetic component, cannot be brought near the MRI apparatus or MRS apparatus. A current-regulated power source would produce a location at the tested subject, at which the electric current flows in a concentrated manner, and thus for safety a voltage regulated power source is better in many cases. The wire extending from the power source to the electrode in the strong magnetic field will experience a force according to Fleming's left-hand rule depending on the magnitude of the electric current, and therefore this conductor is preferably a twisted pair so that the current flows in opposite directions parallel to the static magnetic field as much as possible, or the conductor can be rigidly fixed in the magnetic field.

Detailed Description Text (19):
The computer 11 performs a two-dimensional Fourier transformation with respect to one dataset comprising several echo signals measured repeatedly, and supplies the result to the display 12 as a magnetic resonance image.

Detailed Description Text (24):
In the present invention, in order to detect a diffusion developing isotropically, the b-factor of the MPG should be set to 0.02 to 2,000 s/mm.sup.2 and preferably to 0.2 to 200 s/mm.sup.2. This is because, if the b-factor is small, the influence by the flow of ions or molecules can be contained. If the b-factor is large, then the burden in the manufacture and use of hardware such as the gradient magnetic field coil, etc. is increased.

Detailed Description Text (27):
An acrylic column with a 26 mm inner diameter and 45 mm in length was filled with physiological saline solution. The column was placed as the phantom sample 5 in the magnetic field of an MRI

machine of 1.5 T shown in FIG. 1. Further, the column was connected to the electric current source 6 through the lead wire 7.

Detailed Description Text (30):
In this case, the results obtained when the electric current was applied in parallel to the static magnetic field (i.e., the length direction of the column was set in parallel to the static magnetic field) and when the electric current was applied perpendicular to the static magnetic field (i.e., the length direction of the column was set perpendicular to the static magnetic field), and when the electric current was applied in a direction oblique to the static magnetic field, were the same. Thus, it has also been shown that the T1 shortening effect and the T2 shortening effect of the electric current in the present invention are isotropic.

Detailed Description Text (32):
The acrylic column with a 26 mm inner diameter and 45 mm in length was filled with physiological saline solution. This column was placed in the magnetic field of the MRI machine of 1.5 T, wherein the length direction of the column was set in parallel to the static magnetic field. An MRI image was obtained by the use of a T1-weighted spin echo imaging sequence with a repetition time Tr=300 and an echo time Te=25 ms, applying a direct electric current via platinum planer electrodes of both ends the column.

Detailed Description Text (33):
It was confirmed that the image of which the surface perpendicular to the static magnetic field was a section, the image of which the surface parallel to the static magnetic field was a section, and the image of which a surface oblique to the static magnetic field was a section were all markedly brighter than the images obtained under the same conditions without the application of an electric current, and, in the former, T1 was shortened and isotropically shortened.

Detailed Description Text (34):
Similar imaging experiments were conducted with a repetition time Tr=225 ms, applying an electric current. As a result, the signal intensities of the images obtained were comparable to the signal intensities of the images obtained with application of no electric current and with Tr=300 ms, whereby the imaging time as a whole was reduced by 1/4 with the electric current.

Detailed Description Text (36):
Two aluminum plate electrodes of each 25 cm.sup.2 were attached with conductive glue to both anterior and posterior sides of a human forearm, and the outer side thereof were wound with a cotton bandage. An MRI image was obtained by the use of a T1-weighted spin echo imaging sequence with a repetition time Tr=300 ms and an echo time Te=25 ms, applying a direct electric voltage of 8.0 V to the forearm via the electrodes.

Detailed Description Text (39):
The acrylic column with a 26 mm inner diameter and 45 mm in length was filled with physiological saline solution. The column was placed as the phantom sample 5 in the magnetic field of the MRI machine of 1.5 T as shown in FIG. 1. The ADC was measured by a spin echo imaging sequence with a set of MPG pulses as shown in FIG. 2, with Tr=5000 ms and Te=60 ms, applying a direct electric current via the platinum planer electrodes of both ends of the column. The MPG pulses were applied using a Gr gradient magnetic field as shown in FIG. 2, and the gradient factor attenuation value (b-factor) was set to 25 s/mm.sup.2.

Detailed Description Text (40):
When the current density was 0.0 mA/cm.sup.2 (that is, when no current was applied), the ADC was 0.0021 mm.sup.2 /s. When the current density was 0.2 mA/cm.sup.2, the ADC was 0.020 mm.sup.2 /s. When the current density was 0.5 mA/cm.sup.2, the ADC was 0.079 mm.sup.2 /s. In this case, the same result was obtained when the electric current was applied in parallel to the static magnetic field, when they were applied perpendicular to the static magnetic field, and when it was applied in a direction oblique to the static magnetic field. Thus, it was also proved that the ADC increasing effect according to the present invention was isotropic.

Detailed Description Text (42):
The acrylic column with a 26 mm inner diameter and 45 mm in length was filled with physiological saline solution. The column was placed in the magnetic field of the MRI machine of 1.5 T, wherein the length direction of the column was set in parallel to the static magnetic field. MRI images were obtained by a diffusion-weighted spin echo imaging sequence with MPG

pulses and with Tr=5000 ms and Te=60 ms, applying a direct electric current of 0.2 mA/cm.sup.2 via the platinum planer electrodes of both ends of the column. The gradient factor attenuation value of the MPG was set to 25 s/mm.sup.2.

Detailed Description Text (43):
The image of which the surface perpendicular to the static magnetic field was a section, the image of which the surface parallel to the static magnetic field was a section, and the image of which a surface oblique to the static magnetic field was a section, were all remarkably darker than the images obtained under the same conditions without application of an electric current; and thus it was confirmed that the ADC was remarkably increased and isotropically increased.

Detailed Description Text (45):
Two aluminum plate electrodes of each 25 cm were attached with conductive glue to both anterior and posterior sides of a human forearm, and the outer side thereof was wound with a cotton bandage. An MRI image was obtained by a diffusion-weighted spin echo imaging sequence with MPG pulses and with Tr=5000 ms and Te=60 ms, applying a direct electric voltage of 8.0 V to the forearm via the electrodes. The MPG gradient factor attenuation value of the MPG was set to 42 s/mm.sup.2.

Detailed Description Text (48):
A spherical glass phantom of 18 cm in inner diameter was filled with physiological saline solution. An electrical dipole of 4 cm in length, both ends of which were positive and negative electrodes, was installed in a submerged state at the center of the phantom. Lead-wires were led out from the center and twisted in the phantom so that electromagnetic effects of external currents were canceled. By applying electric voltage from outside, an electric current of 1 mA was made to flow through the spherical saline solution phantom directly from the electrical dipole. T1-weighted (Tr=300 ms, Te=25 ms), T2-weighted (Tr=5000 ms, Te=60 ms) and diffusion-weighted (Tr 5000 ms, Te=60 ms, and MPG Gradient Factor Attenuation b=25 s/mm.sup.2) spin echo magnetic resonance images were obtained.

Detailed Description Text (50):
As mentioned above, according to the present invention, the T1 and T2 of a water-containing substance can be remarkably shortened without using a paramagnetic material or the like such as a gadolinium compound or the like. By shortening the T1, the measuring time of MRI or MRS can be shortened. Further, by the present invention, the ADC of a water-containing substance can be markedly increased.

Current US Original Classification (1):
324/309

Current US Cross Reference Classification (1):
324/300

Other Reference Publication (1):
Tumor Detection By Nuclear Magnetic Resonance, Damadian, Science, vol. 171 (1971) pp. 1151-1153.

CLAIMS:

1. A method for generating magnetic resonance data, selected from the group consisting of image data and spectrum data, comprising the steps of: placing a water-containing substance in a homogenous static magnetic field; applying a radio-frequency field to said substance and thereby exciting nuclear spins in said substance; while said nuclear spins are excited, applying an electrical current through said substance and thereby reducing at least one of spin-lattice relaxation time and a spin-spin relaxation time in said substance; and obtaining a nuclear magnetic resonance signal from said substance resulting from said spins.

3. A method for generating magnetic resonance data, selected from the group consisting of image data and spectrum data, comprising the steps of: placing a water-containing substance in a homogenous static magnetic field; applying a radio-frequency field to said substance and thereby exciting nuclear spins in said substance; while said nuclear spins are excited, applying an electrical current through said substance to reduce the apparent diffusion coefficient of said substance; and obtaining a nuclear magnetic resonance signal from said

substance resulting from said spins.

5. A magnetic resonance imaging apparatus comprising: a basic field magnet which generates a homogenous static magnetic field in which a water-containing substance is disposed; a radio-frequency system which applies a radio-frequency magnetic field to said substance in said homogenous static magnetic field to excite nuclear spins therein; a gradient field system which generates at least one gradient magnetic field in said substance while said spins are excited; a current applicator adapted for interaction with said substance to apply an electrical current through said substance while said nuclear spins are excited therein to reduce at least one of a spin-lattice relaxation time and a spin-spin relaxation time of said substance; said radio-frequency system detecting magnetic resonance signals produced in said substance by said nuclear spins; and a computer system supplied with said magnetic resonance signals which generates a magnetic resonance image therefrom selected from the group consisting of a T1-weighted image and T2-weighted image.

6. A magnetic resonance imaging apparatus comprising: a basic field magnet which generates a homogenous static magnetic field in which a water-containing substance is disposed; a radio-frequency system which applies a radio-frequency field to said substance in said homogenous static magnetic field to excite nuclear spins in said substance; a gradient system which generates at least one gradient magnetic field in said substance while said nuclear spins are excited; said gradient system also generating motion probing gradient pulses in said substance while said spins are excited; an electrical current applicator adapted to apply an electrical current to said substance while said spins are excited therein to increase the apparent diffusion coefficient of said substance; said radio-frequency system obtaining magnetic resonance signals from said substance produced by said nuclear spins; and a computer system supplied with said nuclear magnetic resonance signals which generates a diffusion-weighted image of said substance therefrom.

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☐ 1. Document ID: US 6294972 B1

L40: Entry 1 of 4 File: USPT Sep 25, 2001

US-PAT-NO: 6294972
DOCUMENT-IDENTIFIER: US 6294972 B1
**** See image for Certificate of Correction ****

TITLE: Method for shimming a static magnetic field in a local MRI coil

DATE-ISSUED: September 25, 2001

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Jesmanowicz; Andrzej	Wauwatosa	WI		
Hyde; James S.	Dousman	WI		
Punchard; William F. B.	Sudburry	MA		
Starewicz; Piotr M.	Somerville	MA		

US-CL-CURRENT: 335/301; 324/318, 324/320

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KMC | Draw Desc | Image

☐ 2. Document ID: US 6011394 A

L40: Entry 2 of 4 File: USPT Jan 4, 2000

US-PAT-NO: 6011394
DOCUMENT-IDENTIFIER: US 6011394 A

TITLE: Self-shielded gradient coil assembly and method of manufacturing the same

DATE-ISSUED: January 4, 2000

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Petropoulos; Labros S.	Solon	OH		
Payton; Clarence E.	Chagrin Falls	OH		
Morich; Michael A.	Mentor	OH		
DeMeester; Gordon D.	Wickliffe	OH		

US-CL-CURRENT: 324/318; 324/320

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KMC | Draw Desc | Image

☐ 3. Document ID: US 5003266 A

L40: Entry 3 of 4 File: USPT Mar 26, 1991

US-PAT-NO: 5003266
DOCUMENT-IDENTIFIER: US 5003266 A

TITLE: Passively improving magnetic field homogeneity

DATE-ISSUED: March 26, 1991

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Palkovich; Alex	Oxford			GB
Morad; Ratson	Zichron Yokov			IL

US-CL-CURRENT: 324/320; 324/319

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw Desc | Image

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☐ 4. Document ID: US 4656449 A

L40: Entry 4 of 4 File: USPT Apr 7, 1987

US-PAT-NO: 4656449
DOCUMENT-IDENTIFIER: US 4656449 A

TITLE: Field modifying elements for an electromagnet having a substantially C-shaped yoke

DATE-ISSUED: April 7, 1987

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Mallard; J. R.	Aberdeen AB2 6BG			GB6
Neale; F. E.	Aberdeen AB2 4AJ			GB6

US-CL-CURRENT: 335/297; 324/318, 335/299, 336/211

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw Desc | Image

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BLANKET	95017
BLANKETS	15936
FOIL	336814

FOILS	73414
INSERT$3	0
INSERT	980681
INSERTA	525
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☐ 1. Document ID: US 20070222451 A1

L46: Entry 1 of 7 File: PGPB Sep 27, 2007

PGPUB-DOCUMENT-NUMBER: 20070222451
PGPUB-FILING-TYPE:
DOCUMENT-IDENTIFIER: US 20070222451 A1

TITLE: METHOD AND APPARATUS FOR SHIMMING A MAGNETIC FIELD

PUBLICATION-DATE: September 27, 2007

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY
Feltham; Stuart Paul	Bicester		GB
Hobbs; Matthew	Oxford		GB
Marie Kruip; Marcel Jan	Oxford		GB

US-CL-CURRENT: 324/320; 324/306, 324/318

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KMC | Draw Desc | Image

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☐ 2. Document ID: US 20060261812 A1

L46: Entry 2 of 7 File: PGPB Nov 23, 2006

PGPUB-DOCUMENT-NUMBER: 20060261812
PGPUB-FILING-TYPE:
DOCUMENT-IDENTIFIER: US 20060261812 A1

TITLE: Magnet system and magnetic resonance imaging system utilizing the magnet system

PUBLICATION-DATE: November 23, 2006

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY
Ariyoshi; Akihiko	Tokyo		JP

US-CL-CURRENT: 324/318

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KMC | Draw Desc | Image

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☐ 3. Document ID: US 20050104592 A1

L46: Entry 3 of 7 File: PGPB May 19, 2005

PGPUB-DOCUMENT-NUMBER: 20050104592
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20050104592 A1

TITLE: Bi-planar coil assemblies for producing specified magnetic fields

PUBLICATION-DATE: May 19, 2005

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY
Forbes, Lawrence Kennedy	Hobart		AU
Crozier, Stuart	Wilston		AU

US-CL-CURRENT: 324/318; 335/299

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KWIC | Draw Desc | Image

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☐ 4. Document ID: US 7253624 B2

L46: Entry 4 of 7 File: USPT Aug 7, 2007

US-PAT-NO: 7253624
DOCUMENT-IDENTIFIER: US 7253624 B2

TITLE: Magnet system and magnetic resonance imaging system utilizing the magnet system

DATE-ISSUED: August 7, 2007

PRIOR-PUBLICATION:

DOC-ID	DATE
US 20060261812 A1	November 23, 2006

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Ariyoshi; Akihiko	Tokyo			JP

US-CL-CURRENT: 324/320; 324/319

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw Desc | Image

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☐ 5. Document ID: US 7193417 B2

L46: Entry 5 of 7 File: USPT Mar 20, 2007

US-PAT-NO: 7193417
DOCUMENT-IDENTIFIER: US 7193417 B2

TITLE: Bi-planar coil assemblies for producing specified magnetic fields

DATE-ISSUED: March 20, 2007

PRIOR-PUBLICATION:

DOC-ID DATE

US 20050104592 A1 May 19, 2005

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Forbes; Lawrence Kennedy	Hobart			AU
Crozier; Stuart	Wilston			AU

US-CL-CURRENT: 324/318; 324/309

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw Desc | Image

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☐ 6. Document ID: US 6294972 B1

L46: Entry 6 of 7 File: USPT Sep 25, 2001

US-PAT-NO: 6294972
DOCUMENT-IDENTIFIER: US 6294972 B1
**** See image for Certificate of Correction ****

TITLE: Method for shimming a static magnetic field in a local MRI coil

DATE-ISSUED: September 25, 2001

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Jesmanowicz; Andrzej	Wauwatosa	WI		
Hyde; James S.	Dousman	WI		
Punchard; William F. B.	Sudburry	MA		
Starewicz; Piotr M.	Somerville	MA		

US-CL-CURRENT: 335/301; 324/318, 324/320

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw Desc | Image

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☐ 7. Document ID: US 5760582 A

L46: Entry 7 of 7 File: USPT Jun 2, 1998

US-PAT-NO: 5760582
DOCUMENT-IDENTIFIER: US 5760582 A
**** See image for Certificate of Correction ****

TITLE: Optimized gradient coils and shim coils for magnetic resonance scanning systems

DATE-ISSUED: June 2, 1998

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Morrone; Terry	Greenlawn	NY		

US-CL-CURRENT: 324/318; 324/322

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw Desc | Image

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Term	Documents
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SHIMS	27657
PATIENT	627741
PATIENTS	333205
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SUBJECTS	157015
OBJECT	5243645
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